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LEAFHOPPERS (CICADELLIDAE) ASSOCIATED WITH THE  
STONE FRUIT ORCHARDS OF NORTHERN UTAH

by

Mervin W. Nielson

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

MASTER OF SCIENCE

in

Entomology

1950

UTAH STATE AGRICULTURAL COLLEGE  
Logan, Utah

Approved:

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Major Professor

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Head of Department

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Dean of Graduate School

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## INTRODUCTION

Virus diseases of stone fruit orchards have existed in Utah for more than a quarter of a century (31) and are seriously diminishing the peach and cherry fruit production. Western X of peach, rusty mottle of cherry, wilt and decline of cherry, and little cherry constitute the most economically important stone fruit virus diseases in Utah. Many orchards, particularly in Davis County, have 50 to 83 percent of the trees infected with one or more of the yellow-red viroses (37). Surveys have shown that the diseases are spreading from 3 to 5 percent each year (14). It is believed that certain insects are responsible for the natural spread of the virus diseases of stone fruits. Some inconclusive evidence points to leafhoppers as the potential vectors since many cicadellidids are capable of transmitting virus to plants during the feeding process. They have maintained a reputation for being efficient vectors of plant viruses for many years, as well as inducing other types of plant injury. Their adaptable, piercing-sucking mouth parts inoculate plants with filterable viruses taken in from infected plants. They inflict other types of damage to the host by injecting toxic substances. The most severe type of damage, however, is that caused through the virus infection which generally is systemic.

The purpose of this investigation was to determine the occurrence, seasonal abundance, and host preference of leafhoppers occurring in the stone fruit orchards of northern Utah. Leafhopper occurrence in

plant environs adjacent to the stone fruit orchards was also studied. Studies were made to determine if any correlation existed between leafhopper abundance and percentage of diseased trees in the orchards. Trap studies and surveys seemed to be the most appropriate technique in approaching this problem. The trap studies were conducted in fifteen stone fruit orchards in five counties of northern Utah. Surveys were undertaken in most stone fruit growing areas in the northern part of the state.

Many leafhoppers are economically important as vectors of viruses causing plant diseases. The beet leafhopper, Circulifer tenellus (Bak.), transmits curly top virus to sugar beets, tomatoes, cantaloupes, and to other important crops (8). The six-spotted leafhoppers, Macrosteleus divisa (Uhl.), is important as a vector of aster-yellows virus of celery, carrots, and other umbelliferous plants (38). Recently four species of leafhoppers were found to be the vectors of phony peach disease (39). There are numerous other leafhopper species that are destructive carriers of plant viruses.

The biological development of leafhoppers varies substantially between species. Some species spend as long as 10 months in the nymphal stage, while many others spend 3 weeks as nymphs before becoming adults. Leafhoppers may over-winter in the adult, nymph, or egg stage, depending upon the species. The over-wintering eggs are usually present in the plant tissues and hatch late in the spring. Leafhoppers that pass through the winter as adults normally emerge from hibernation early in the spring and begin to lay eggs. The eggs hatch in about ten days (10). There are five nymphal instars before

the adult stage which generally take from twelve to thirty days, depending upon the species and climatic conditions. One or more generations occur a year, depending upon the species and seasonal climatic conditions.

Many leafhopper species are restricted to certain plant genera and species for a source of food while other species have a wide host range. The host plants consist mainly of different types of grasses; however, the woodland areas of herbaceous and woody dicotyledonous plants are host to many species of leafhoppers.

#### Review of Literature

Very little has been written concerning the relationship of leafhoppers to virus diseases of stone fruit orchards of Utah. However, much has been reported on leafhopper occurrence.

In 1906, Ball (3) reported the relationship of the beet leafhopper to the curly top disease of sugar beets in Utah.

In 1923, Hawley (13) reported a heavy population of beet leafhoppers in Utah with serious damage occurring in sugar beet fields in some sections of the state.

In 1927, Knowlton (16) recorded 27 species of leafhoppers collected on various host plants in Utah; in 1931 (17), 13 species; in 1932 (20), 3 species; in 1934 (18), 56 species; and in 1935, (19), 47 species were listed.

In 1936, Knowlton and Allen (21) recorded 141 species of leafhoppers collected in Utah.

In 1949, Knowlton and Nielson (22) recorded 175 species of leafhoppers collected in Utah.

In 1950, Kaloostian (14) reported that more than 200 species of insects, mostly leafhoppers, had been used in 1500 tests in search for the vectors of the stone fruit virus in Utah.

## METHODS OF PROCEDURE

During 1949 fifteen stone fruit orchards were selected in northern Utah for this study. They were as follows: Two peach and one chokecherry in Cache County; one peach and one plum in Boxelder County; one cherry in Weber County; five peach, one apricot, and one cherry in Davis County; and two peach orchards in Utah County.

Description of Orchards

## Cache County: Providence

A. Baer property--peach, Prunus Persica (L.): This orchard consisted of two hundred ninety-seven 6- to 10-year-old trees of Early Elberta variety. The plant environs were alfalfa on the south and west sides, and sagebrush and cultivated crops on the east and north sides, respectively. The orchard was semi-clean throughout the growing season. Spray materials were applied twice, once in June and again in July.

G. Bankhead property--peach, Prunus Persica (L.): This 10-year-old orchard contained 87 trees of Early Elberta variety. It was bordered by a pear orchard on the west side and sagebrush on the south, east, and north sides. The orchard was in heavy grass sod together with various weeds. No spray materials were applied during the growing season.

J. Ream property--wild chokecherry, Prunus virginiana (L.): This plot of wild chokecherry was 20 years old and was surrounded by a peach orchard on the south side and cultivated crops on the east,

north, and west sides. There were approximately 25 bushes together with heavy sucker growth extending over a distance of 25 by 75 yards.

Boxelder County: Willard

W. White property--peach, Prunus Persica (L.): The 250 trees in this 30-year-old orchard were of Early Elberta and Hale varieties. Apricot, prune, and peach bordered the orchard on the north, east, and south sides, respectively. Highway 91 ran along the west side. The orchard was cultivated and irrigated regularly throughout the growing season. It was sprayed twice during the summer.

W. White property--plum, Prunus domestica L. This 30-year-old orchard contained 89 trees of Italian variety. The plant environs adjacent were peach, plum, apricot, and peach on the west, north, east, and south sides, respectively. The orchard was cultivated regularly during the growing season. No spray materials were applied, however.

Weber County: North Ogden

J. Campbell property--sweet cherry, Prunus avium L.: This orchard contained seventy-two 40-year-old trees of Lambert variety on Mazzard rootstocks, Prunus avium L. The orchard was bordered by peach, apricot, sweet cherry, and cultivated crops on the east, south, west, and north sides, respectively. It was cultivated and irrigated regularly throughout the summer. No spray materials were applied.

Davis County: Farmington

S. Moon property--peach, Prunus Persica (L.): The 126 trees in this orchard were 20 years old. They were of the early Elberta and Hale varieties. Sweet cherry orchards lay on the north,

west, and south sides. Grain bordered it on the east side. This orchard was cultivated regularly. One spray application was applied during the summer.

S. Moon property--sweet cherry, Prunus avium L.: This orchard was 40 years old and had 52 trees of Lambert variety on Mahaleb rootstocks, Prunus mahaleb L. The orchard was bordered by sweet cherry and peach on the west and north sides, respectively; and oak brush on the east and south sides. A grass cover crop was present most of the summer. One application of parathion was made during the growing season.

Davis County: Centerville

R. White property--apricot, Prunus Armeniaca L.: There were 180 trees present in this 20-year-old orchard. Sagebrush bordered the orchard on the east and south sides. A highway ran along the west portion of the orchard. The orchard was clean-cultivated throughout the entire growing season. No spraying was done in this orchard.

W. Smith property--peach, Prunus Persica (L.): This orchard contained eighty-three 40-year-old trees of Elberta variety. The plant environs adjacent were grapes, alfalfa, and grain on the south, west, and north sides, respectively. A highway bordered the east side. The orchard was partially cultivated during the summer. The orchard was sprayed once with nicotine and lead arsenate.

Davis County: Bountiful

L. Eckman property--peach, Prunus Persica (L.): This comparatively young orchard consisted of two hundred 5-year-old trees of

Early Elberta and Hale varieties. It was bordered by oak and cultivated crops on the south and west sides, respectively. A road ran along the north and east sides. The orchard was cultivated and irrigated during the major growing season. One application of DDT and parathion was applied during the summer.

J. Stringham property--peach, Prunus Persica (L.): This orchard had two hundred seventy 5-year-old trees of Early Elberta variety. It was bordered by apricot and sweet cherry on the north and east sides, respectively. A road lay along the west and south sides. The orchard was partially cultivated during the growing season. DDT and parathion were applied three times during the summer months.

L. Barlow property--peach, Prunus Persica (L.): There were one hundred nine 4-year-old trees of Early Elberta variety in this orchard. Peas, peach, and sweet cherry bordered the orchard on the south, west, and north sides, respectively. The orchard was kept clean-cultivated throughout the summer. Three spray applications of DDT and parathion were made during the summer.

Utah County: North Provo

E. Smith property--peach, Prunus Persica (L.): This orchard contained five hundred 40-year-old trees of Elberta variety. Cherry, apricot, sagebrush, and sweet cherry bordered the orchard on the west, north, east, and south sides, respectively. It was partially cultivated during the summer. The orchard was sprayed twice, first with DDT and the second time with parathion.



Utah County: Mapleton

G. Seale property--peach, Prunus Persica (L.): This 10-year-old orchard had 1,392 trees of Elberta variety. It was bordered by peach, sweet cherry, and cultivated crops on the west, north, and east sides, respectively. Weed and grass cover crop was present and no disking or cultivating was done throughout the summer. Also, spray materials were not applied during the season.

### Materials and Methods

Two techniques were used in collecting leafhoppers for study. Sticky-trap boards (figs. 1 and 2) were improvised as the method of capturing leafhoppers in the orchards. The traps were 5 inches wide, 10 inches long, and 1/4 inch thick (fig. 3). Traffic-yellow paint was applied to serve as an attractant for the insects. "Deadline," an extremely tacky substance, was applied to each board by running it through a hand-wringer coated with the substance. This afforded an even and well distributed covering. One 12-inch bailing wire was passed through a hole at the top of each trap and twisted to form a loop. One hundred fifty traps were exposed and renewed during the first week of each month. Ten traps were distributed in each orchard. The first set was distributed on May 5 and 6, 1949; and the last set was collected on October 5 and 14, 1949. A total of 750 traps was exposed during the entire season. The leafhoppers were saturated with kerosene and picked off with a small flattened nail. All specimens were washed with solvent and relaxed in alcohol before being sent to Washington, D. C. for identification.

The second technique was the use of a sweep net, aspirator, and collecting vials (figs. 4 and 5) for gathering leafhoppers in the plant environs adjacent to the stone fruit orchards. The area swept was within a one-half mile radius of a stone fruit orchard.



Figure 1. A sticky-trap board suspended from a branch of a peach tree.



Figure 2. Close-up of a sticky-trap board suspended from a branch of a peach tree which had numerous insects already captured.

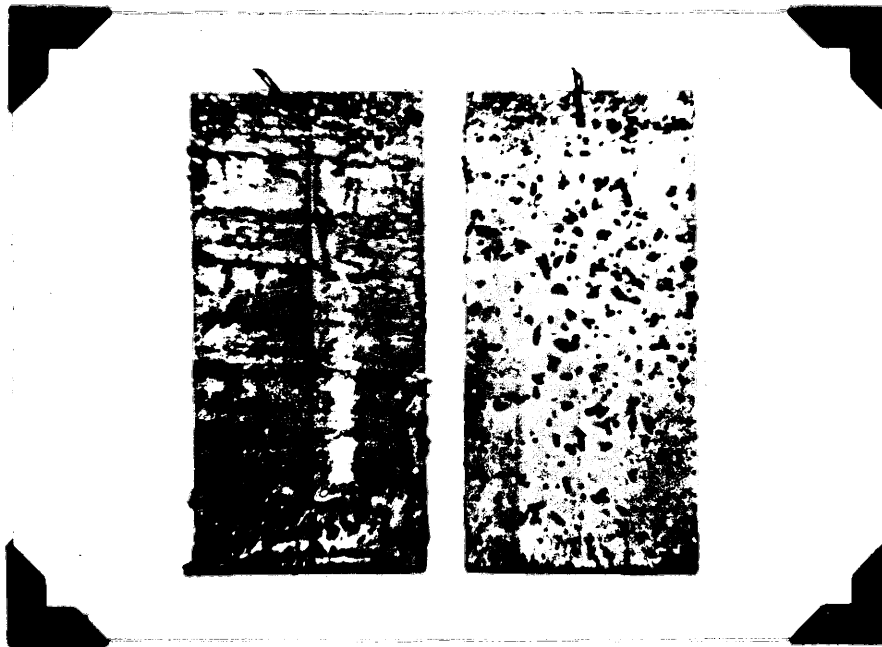


Figure 3. Two sticky-trap boards showing captured insects. Scale about 1/5 actual size.



Figure 4. A sweep net used in the collection of leafhoppers.

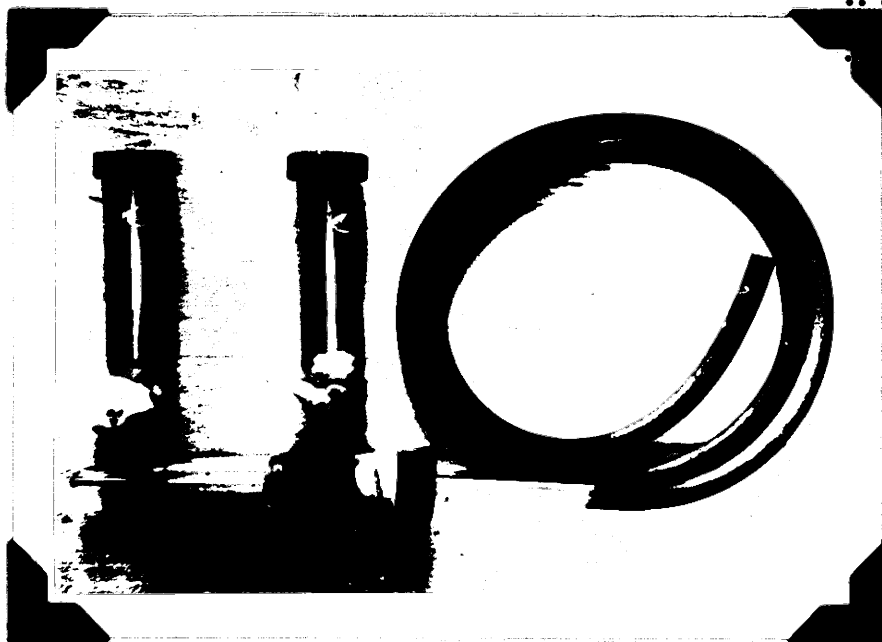


Figure 5. Collection apparatus used to capture leafhoppers in the sweep net.

## PRESENTATION AND DISCUSSION OF RESULTS

Seasonal Abundance of Leafhoppers

The number of leafhopper species collected on 750 sticky-trap boards from May to September, 1949, in 15 stone fruit orchards of northern Utah is shown in table 1. The seasonal abundance and total collected through the season for each species are also indicated. There were 88 species collected from the orchards of northern Utah.

Colladonus geminatus (Van D.) was the most prevalent species with a total of 8,386 specimens collected from May to September. Two generations occurred during the season. The first peak occurred in June and the second or highest peak was reached in September (fig. 6).

Paraphlepsius irroratus (Say) totaled 7,755 specimens for the season. This species also underwent two generations. The highest peak, however, occurred in June (fig. 6).

Typhlocyba rosae (L.) totaled 5,162 specimens with one generation during the season. The peak was reached in July (fig. 6).

Empoasca maligna Walsh numbered 4,142 specimens for the season. The figures indicated that this species underwent one generation with a peak in July (fig. 6).

Dikraneura carneola (Stal) totaled 676 specimens with three generations during the season. The first peak came in May, the second in July, and the third or highest peak took place in September.

Osbornellus borealis DeL. & M. totaled 629 specimens for the season. One generation occurred with a peak in September (fig. 6). All other species listed in this table were not collected in sufficient numbers to determine the number of generations.

Table 1. Leafhoppers collected on sticky-trap boards in 15 stone fruit orchards in northern Utah, May-September, 1949.

Leafhopper Species	May	June	July	August	September	Total
<u>Acusana</u> sp.	0	0	0	2	0	2
<u>Agallionis novellina</u> Oman	0	3	1	0	0	4
<u>Agalliopsis</u> sp.	0	0	0	1	0	1
<u>Aligia</u> sp.	0	0	4	4	3	11
<u>Aphrodes albifrons</u> (L.)	0	0	0	1	0	1
<u>Balclutha impicta</u> (Van D.)	0	0	4	0	0	4
<u>Balclutha</u> sp.	1	1	1	0	0	3
<u>Ballana bicornis</u> DeL.	0	0	2	0	0	2
<u>Ballana</u> sp.	0	0	1	0	0	1
<u>Calladonus coquillettii</u> (Van D.)	0	0	1	0	0	1
<u>Chlorotettix stolatus</u> Ball	0	0	0	0	1	1
<u>Chlorotettix</u> sp.	0	0	0	0	2	2
<u>Cicadella</u> sp.	0	0	7	2	0	9
<u>Circulifer tenellus</u> (Baker)	0	1	0	0	0	1
<u>Calladonus belli</u> (Uhler)	11	4	423	99	6	543
<u>C. citrinifrons</u> (C. & B.)	0	0	0	0	4	4
<u>C. flavocapitatus</u> (Van D.)	0	0	8	14	219	241
<u>C. geminatus</u> (Van D.)	200	633	274	549	6730	8386
<u>C. montanus</u> (Van D.)	0	65	39	45	119	268
<u>Calladonus</u> sp.	0	1	0	1	2	4
<u>Deltocephalus grex</u> Oman	0	0	2	0	0	2
<u>Dikraneura carneola</u> (Stal)	150	53	78	23	372	676
<u>Dikraneura</u> sp.	0	16	0	0	0	16
<u>Dikrella cruentata</u> (Gill.)	0	0	23	2	1	26

Table 1. Continued

Leafhopper Species	May	June	July	August	September	Total
<u>Empoasca abrupta</u> DeL.	0	1	0	0	0	1
<u>E. alboneura</u> Gill.	0	0	2	8	22	32
<u>E. deluda</u> DeL.	0	1	0	0	0	1
<u>E. filamenta</u> DeL.	14	60	86	60	51	271
<u>E. maligna</u> Walsh	0	840	1699	924	679	4142
<u>E. panda</u> DeL.	0	1	0	0	0	1
<u>E. pectinata</u> DeL.	0	0	1	0	0	1
<u>E. pergandei</u> Gill.	0	0	8	0	0	8
<u>Empoasca</u> sp.	33	39	7	6	69	154
<u>Empoasca</u> sp. <u>aspera</u> group	2	0	0	0	0	2
<u>Empoasca</u> sp. <u>fabae</u> group	0	1	0	0	0	1
<u>Empoasca</u> ( <u>kybos</u> ) sp.	1	12	6	5	14	38
<u>Empoasca</u> spp.	0	5	4	6	8	23
<u>Erythroneura zizac</u> Walsh	28	10	406	59	3	506
<u>Erythroneura</u> sp.	3	39	135	138	11	326
<u>Erythroneura</u> sp. <u>obliqua</u> gr.	0	0	9	0	0	9
<u>Erythroneura</u> sp. <u>vulnerata</u> gr.	0	0	1	0	0	1
<u>Erythroneura</u> spp.	98	3	15	25	61	202
<u>Euscelidius schenkii</u> (Kbm.)	0	2	10	10	0	22
<u>Eutettix aequalis</u> Hopner	0	1	0	0	0	1
<u>Eutettix</u> sp.	0	0	2	8	7	17
<u>Pieborrella florii</u> (Stal)	0	0	9	46	16	71
<u>Gypona verticalis</u> Stal	0	0	18	68	13	97
<u>Gypona</u> sp.	0	0	0	0	3	3
<u>Gypona hasta</u> DeL.	0	1	0	0	0	1
<u>Gypona</u> sp.	0	0	2	15	4	21
<u>Helochara</u> sp.	0	0	1	1	0	2



Table 1. Continued

Leafhopper Species	May	June	July	August	September	Total
<u>Idiodon</u> <u>cockerelli</u> (Ball)	0	0	0	1	0	1
<u>Idiocerus</u> <u>alternatus</u> Fitch	0	0	0	0	2	2
<u>I.</u> <u>aseonus</u> Van D.	0	0	0	1	1	2
<u>I.</u> <u>duzcei</u> Prov.	0	0	1	0	0	1
<u>I.</u> <u>norosus</u> Ball	0	0	1	0	0	1
<u>I.</u> <u>provancheri</u> Van D.	0	0	4	0	0	4
<u>I.</u> <u>snowi</u> G. & B.	0	0	3	0	0	3
<u>Idiocerus</u> sp.	1	0	7	7	3	18
<u>Idiocerus</u> spp.	0	0	2	0	0	2
<u>Macropsis</u> sp.	0	1	1	0	0	2
<u>Macrostelus</u> <u>divisus</u> (Uhl.)	13	20	53	9	4	99
<u>Neococclidius</u> <u>obscura</u> Baker	0	0	0	1	0	1
<u>Nervellina</u> <u>chenopodii</u> (Osb.)	0	0	4	9	7	20
<u>N.</u> <u>scitula</u> (Ball)	0	0	0	2	1	3
<u>Nervellina</u> sp.	0	2	1	0	0	3
<u>Onconsis</u> <u>verticis</u> (Say)	0	9	1	1	1	12
<u>Opsius</u> <u>stactogalus</u> Fieber	0	0	0	1	1	2
<u>Osbornellus</u> <u>borealis</u> DeL. & M.	0	0	100	248	281	629
<u>Osbornellus</u> sp.	0	1	0	0	0	1
<u>Paraphlepsius</u> <u>irroratus</u> (Say)	245	3436	226	1270	2578	7755
<u>P.</u> <u>occidentalis</u> (Bak.)	0	0	6	0	0	6
<u>Paraphlepsius</u> sp.	0	0	0	1	0	1
<u>Pseumnotettix</u> sp.	0	5	2	2	1	10
<u>Scaphoideus</u> near <u>crassus</u>	0	0	4	11	0	15
<u>Scaphoideus</u> sp.	0	0	12	6	2	20
<u>Scaphytopius</u> <u>acutus</u> (Say)	0	2	12	16	40	70
<u>Scaphytopius</u> sp.	1	5	0	1	0	7

Table 1. Continued.

Leafhopper Species	May	June	July	August	September	Total
<u>Sclerorhynchus</u> sp.	0	0	0	1	0	1
<u>Strigamia</u> sp.	0	0	3	0	0	3
<u>Texanorhynchus spatulatus</u> (Van D.)	0	0	2	3	7	12
<u>Typhlocyba flavomarginata</u> G. & B.	0	0	5	0	0	5
<u>T. pomaria</u> McA.	7	45	104	134	9	299
<u>T. prunicola</u> Edw.	26	113	13	2	27	181
<u>T. rosae</u> (L.)	23	1168	2212	971	788	5162
<u>Typhlocyba</u> sp.	24	55	14	13	78	184
<u>Typhlocyba</u> spp.	0	10	2	18	13	43
<u>Xerophloea</u> sp.	0	0	1	1	0	2
TOTAL	881	6,665	6,083	4,852	12,252	30,733

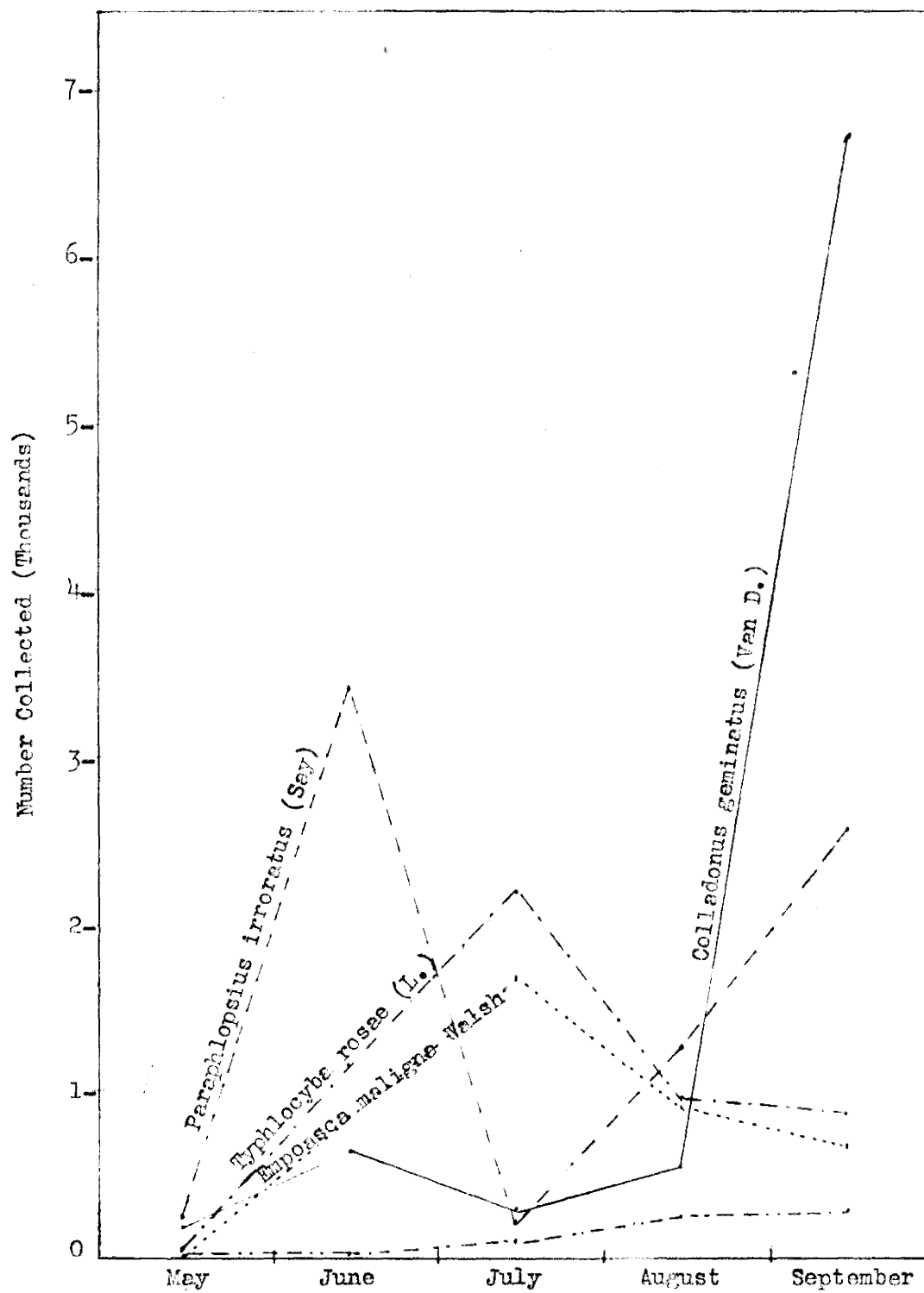


Figure 6. Seasonal abundance of five dominant species of leafhoppers in 15 stone fruit orchards in northern Utah, 1949.

The total number of leafhoppers collected on sticky traps reached 881 in May; 6,665 in June; 6,083 in July; 4,852 in August; and 12,252 in September. The number of leafhoppers collected throughout the entire season totaled 30,733. In general, these figures suggested that two generations occurred during the season. The first peak came in June, and second or highest one took place in September (fig. 7).

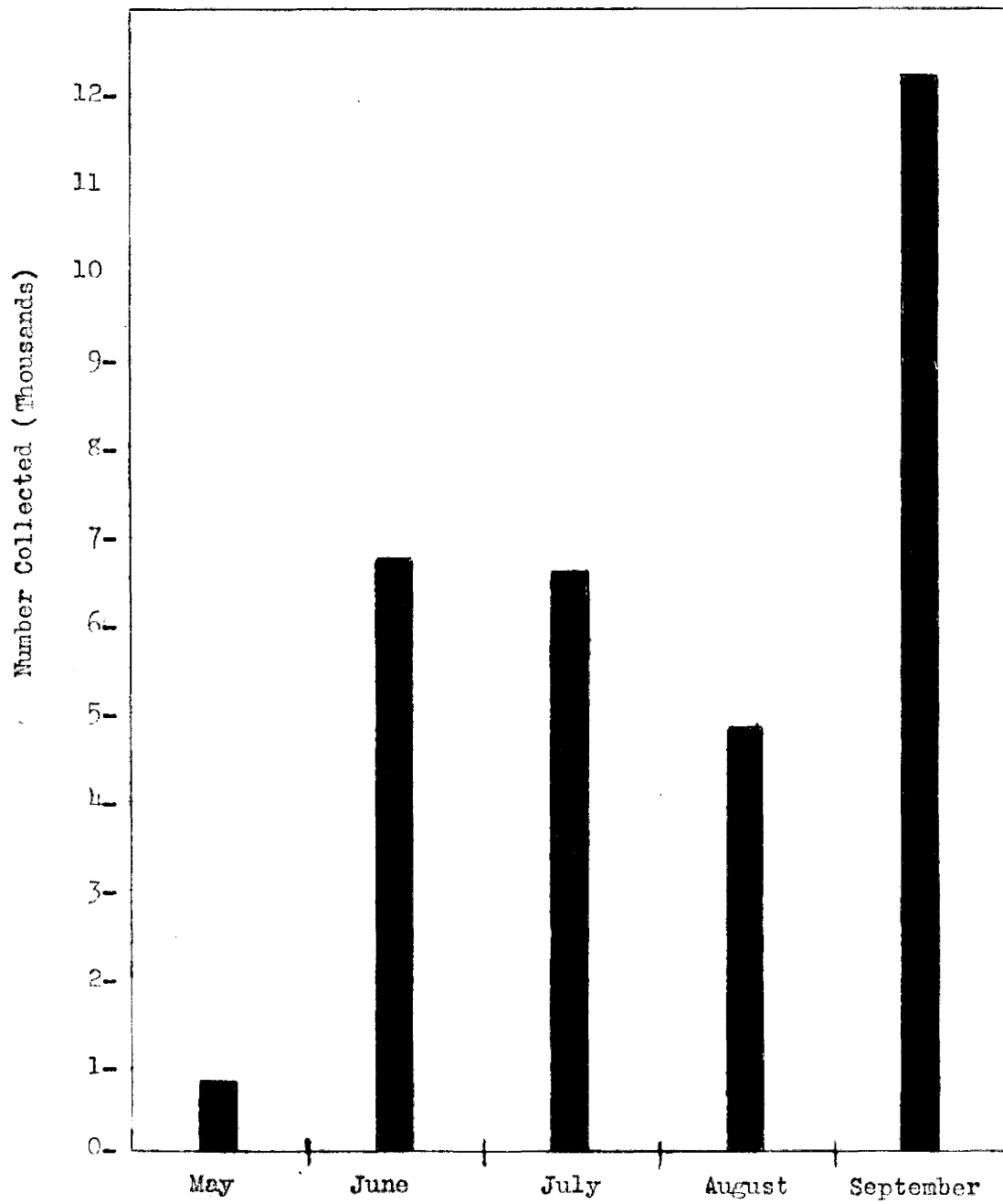


Figure 7. Seasonal abundance of leafhoppers collected on sticky-trap boards in 15 stone fruit orchards of northern Utah, 1949.

### Total Seasonal Abundance of Leafhoppers in Each Orchard

Table 2 shows the seasonal abundance of leafhoppers collected on sticky-trap boards from May to September, 1949, in each stone fruit orchard studied in northern Utah.

In Seale's peach orchard 1,452 leafhoppers were collected during the season. Two generations occurred with a high peak in July. The unusual peak in July was due to the abundant population of Colladonus belli (Uhl.) (fig. 8). This orchard was never sprayed and bore a heavy cover crop throughout the season. Such cultural practices as these account for large leafhopper populations (fig. 9). In contrast with the above orchard, only 241 leafhoppers were collected in E. Smith's peach orchard during the season. This orchard was cultivated and sprayed during the growing season. The leafhoppers collected for each month in this orchard (table 2) do not clearly show the number of generations.

Baer's and Bankhead's peach orchards had high populations of leafhoppers; both had two generations during the season. The peaks for both orchards occurred in June and September. A total of 2,764 leafhoppers were collected in the Bankhead orchard in contrast to 1,923 leafhoppers in the Baer orchard.

The peach orchards of W. White, Barlow, Eckman, and Stringham displayed low populations of leafhoppers. The figures indicated are not sufficient to depict the number and date of leafhopper generations. These orchards, however, were sprayed and well cultivated during the growing season, which accounts for such low abundance of leafhoppers.

Table 2. Seasonal abundance of leafhoppers in 15 stone fruit orchards in northern Utah, 1949.

Property	May	June	July	August	September	Total
G. Seales--peach	39	154	476	259	524	1452
E. Smith--peach	33	22	14	30	142	241
A. Baer--peach	23	330	161	99	1310	1923
G. Bankhead--peach	31	248	138	233	2114	2764
W. White--peach	24	82	38	92	398	634
W. Smith--peach	87	383	300	163	454	1385
S. Moon--peach	58	357	127	268	1082	1892
L. Barlow--peach	92	101	122	23	37	375
L. Eckman--peach	52	24	32	75	185	368
J. Stringham--peach	55	101	132	52	63	405
J. Campbell--cherry	92	1373	1661	1259	1916	6301
S. Moon--cherry	-	2879	2524	1409	996	7808
R. White--apricot	208	337	60	352	613	1570
W. White--plum	64	184	24	201	857	1330
R. Ream--chokecherry	23	90	274	337	1561	2285
TOTAL	881	6665	6083	4852	12,252	30,733

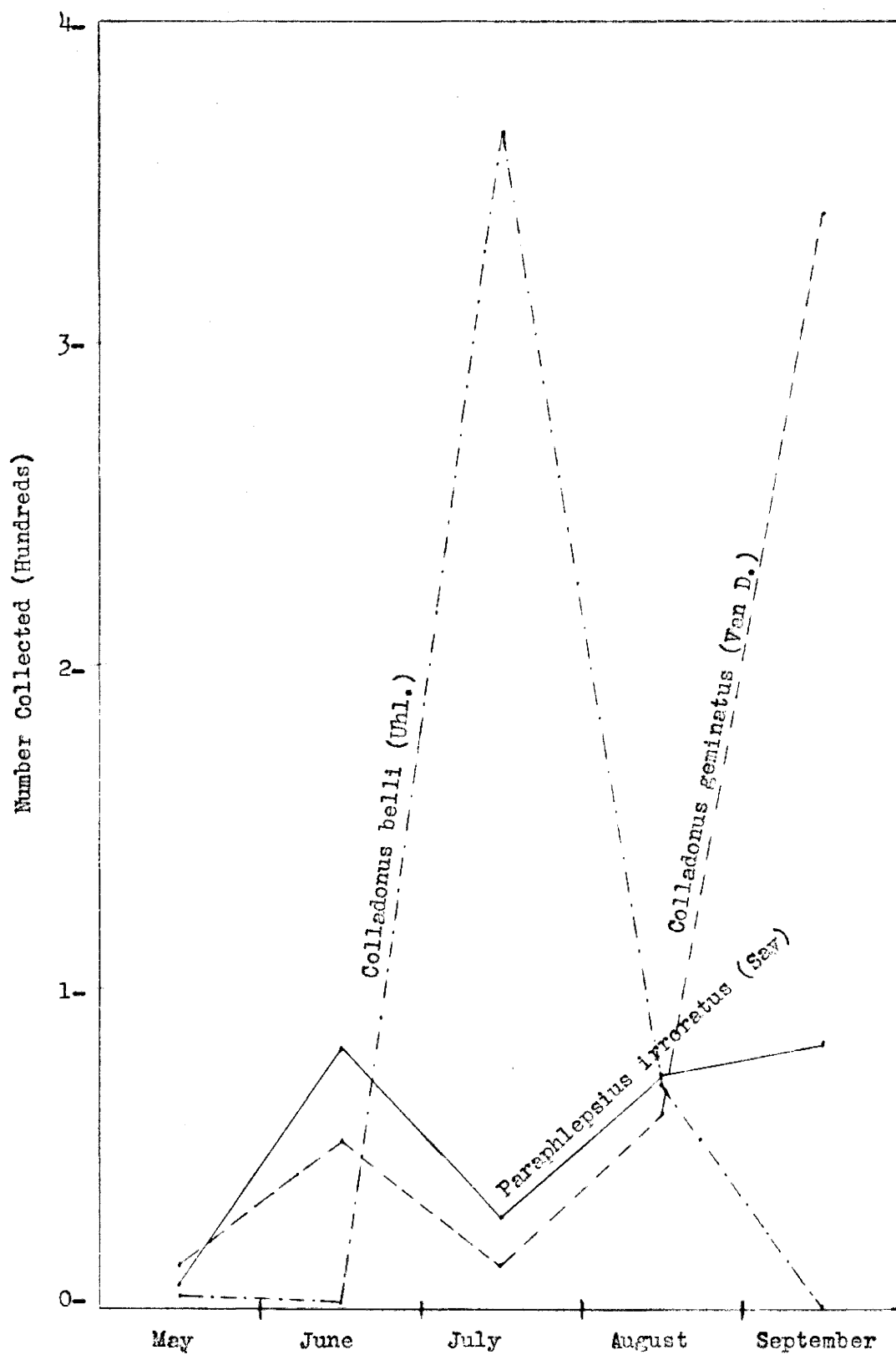


Figure 8. Seasonal abundance of three dominant species of leafhoppers in G. Seale's peach orchard, Utah County, 1949.



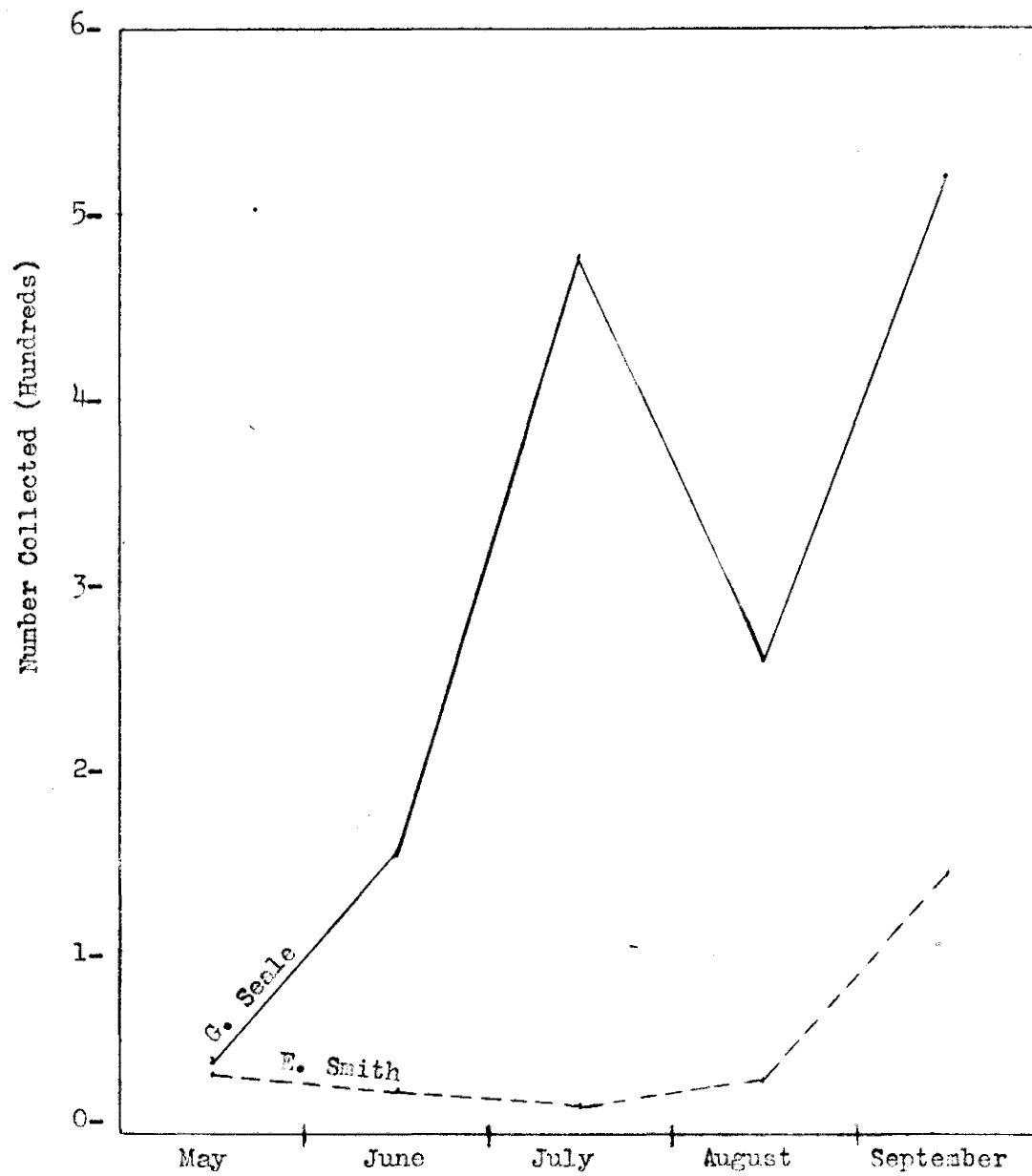


Figure 9. Seasonal abundance of leafhoppers in two peach orchards in Utah County, 1949.

W. Smith's and Moon's peach orchards had moderately high leafhopper populations. Two generations occurred for both orchards with the peaks in June and September.

The highest leafhopper populations were found in Campbell's and Moon's cherry orchards, which totaled 6,301 and 7,807. This high number was attributed to the dominant species of Typhlocyba rosae (L.), Eranasca maligna Walsh, and Paraphlepsius irroratus (Say) (figs. 10 and 11). These two orchards differ in respect to the number of generations. Two generations occurred in the Campbell orchard with the peaks in July and September. In the Moon orchard only one generation occurred with the peak in June.

R. White's apricot, W. White's plum, and Ream's chokecherry orchards yielded fairly high populations of leafhoppers. Two generations occurred in R. White's apricot and W. White's plum orchard. Only one generation occurred in Ream's chokecherry with the peak in September.

In general, the number of generations varied considerably in the orchards studied. The highest peak of leafhoppers occurred in September in nearly all the orchards.

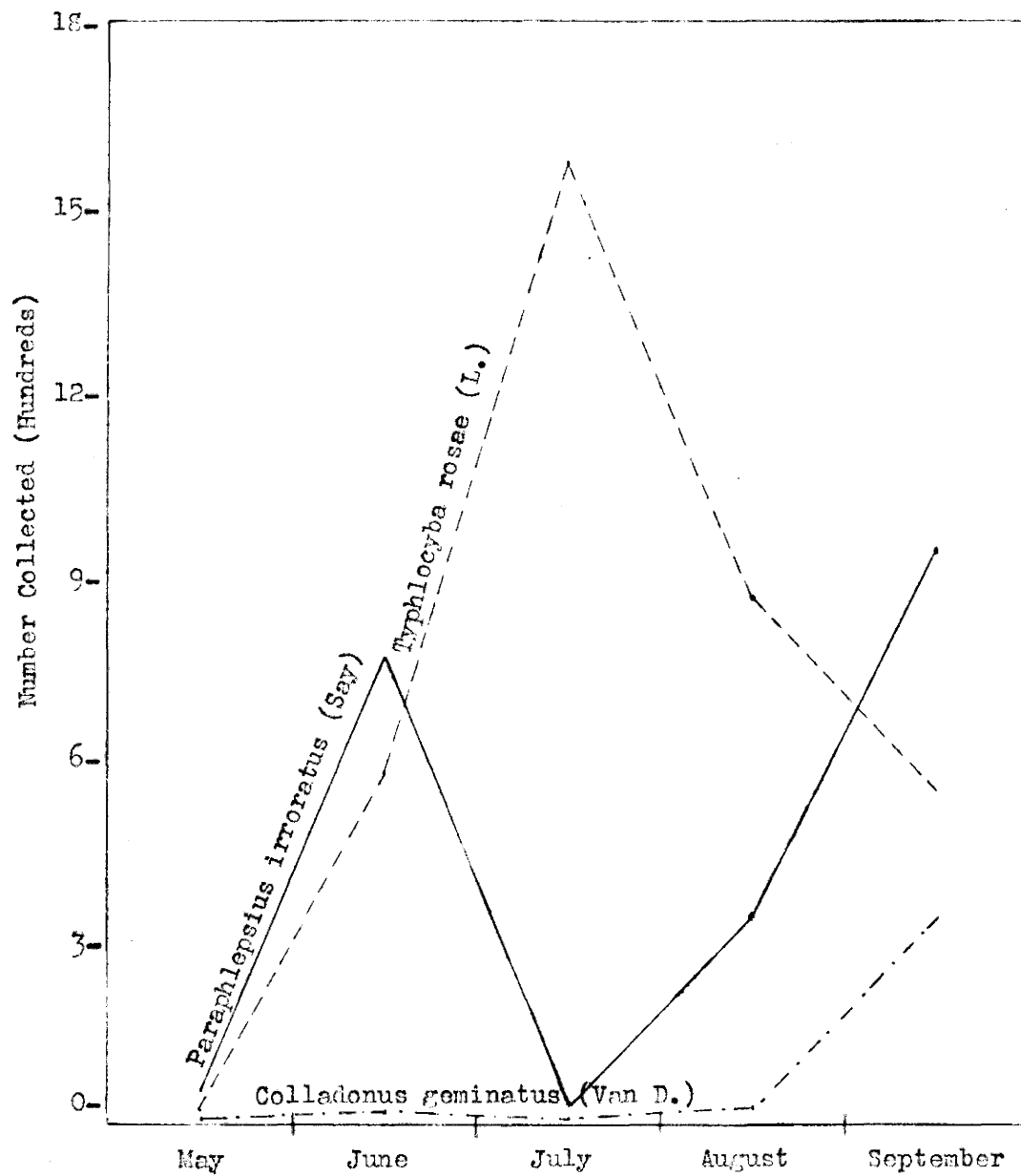


Figure 10. Seasonal abundance of three dominant species of leafhoppers in Campbell's cherry orchard, Weber County, 1949.

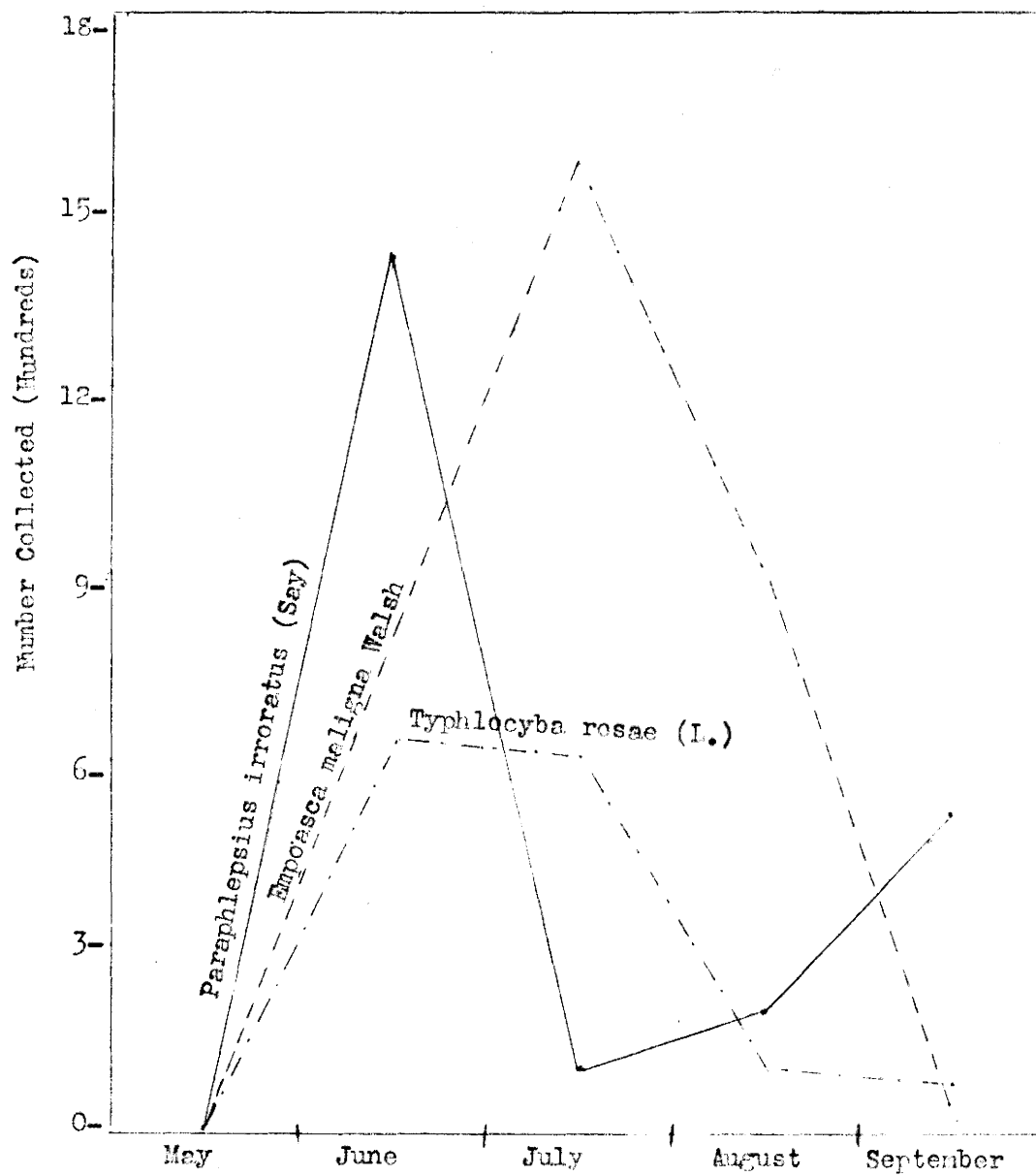


Figure 11. Seasonal abundance of three dominant species of leafhoppers in Moon's cherry orchard, Davis County, 1949.

### The Dominant Species of Leafhoppers in Each Orchard

Table 3 shows the seasonal abundance of the dominant species of leafhoppers collected on sticky traps in each stone fruit orchard in northern Utah.

The dominant species in Seale's peach orchard were Colladonus belli (Uhl.), C. geminatus (Van D.), and Paraphloeosius irroratus (Say). Colladonus geminatus (Van D.) and P. irroratus (Say) produced two generations during the season with peaks in June and September. Colladonus belli (Uhl.) passed through the season with one generation with a peak in July (fig. 9).

Colladonus geminatus (Van.D.) and P. irroratus (Say) were the predominant species in E. Smith's, W. Smith's, Stringham's and W. White's peach orchards and P. White's apricot orchard. Both species underwent two generations during the season with peaks in June and September. The peak for P. irroratus (Say) was higher in June than the peak of C. geminatus (Van D.) which reached its high in September.

Three dominant species of leafhoppers were collected in the Campbell cherry orchard; namely, Colladonus geminatus (Van D.), P. irroratus (Say), and T. rosae (L.). The two former species underwent the usual two generations per season with peaks in June and September. The latter species underwent one generation with the peak in July (fig. 10).

Erroasca maligna Walsh, P. irroratus (Say), and Ephlocyba rosae (L.) were the predominant species on Moon's cherry orchard. One generation occurred during the season for T. rosae (L.) and E. maligna

Table 3. Seasonal abundance of dominant species of leafhoppers in 15 stone fruit orchards in northern Utah, 1949.

Property	Leafhopper Species	May	June	July	August	September
G. Seale--peach	<u>Colladonus belli</u>	6	4	366	71	1
	<u>Colladonus geminatus</u>	13	54	14	61	340
	<u>Paraphlepsius irroratus</u>	8	82	28	72	83
E. Smith--peach	<u>Colladonus geminatus</u>	6	7	4	1	110
	<u>Paraphlepsius irroratus</u>	0	4	1	1	4
A. Baer--peach	<u>Colladonus geminatus</u>	6	172	74	63	1183
G. Bankhead--peach	<u>Colladonus geminatus</u>	7	144	41	93	1470
W. White--peach	<u>Colladonus geminatus</u>	7	6	6	36	219
	<u>Paraphlepsius irroratus</u>	5	59	2	37	71
W. Smith--peach	<u>Colladonus geminatus</u>	23	31	2	45	330
	<u>Paraphlepsius irroratus</u>	24	327	3	24	73
S. Moon--peach	<u>Colladonus geminatus</u>	24	59	20	91	843
	<u>Dikraneura carneola</u>	8	6	11	3	47
	<u>Paraphlepsius irroratus</u>	23	255	2	92	157
L. Barlow--peach	<u>Colladonus geminatus</u>	29	33	5	6	15
L. Eckman--peach	<u>Colladonus geminatus</u>	10	5	3	28	138
	<u>Dikraneura carneola</u>	7	4	4	1	9
	<u>Paraphlepsius irroratus</u>	2	4	2	17	19

Table 3. Continued

Property	Leafhopper Species	May	June	July	August	September
J. Stringham--peach	<u>Colladonus geminatus</u>	7	17	4	3	10
	<u>Paraphlepsius irroratus</u>	2	31	1	9	10
J. Campbell--cherry	<u>Colladonus geminatus</u>	6	13	5	20	1400
	<u>Paraphlepsius irroratus</u>	54	759	19	349	949
	<u>Typhlocyba rosae</u>	20	559	1612	855	542
S. Moon--cherry	<u>Empoasca maligna</u>	-	815	1607	907	42
	<u>Paraphlepsius irroratus</u>	-	1400	115	133	408
	<u>Typhlocyba rosae</u>	-	627	606	107	52
R. White--apricot	<u>Colladonus geminatus</u>	61	31	4	3	392
	<u>Paraphlepsius irroratus</u>	115	285	5	298	170
W. White--plum	<u>Colladonus geminatus</u>	11	4	3	28	316
	<u>Paraphlepsius irroratus</u>	12	71	1	162	487
	<u>Typhlocyba prunicola</u>	22	100	13	1	27
J. Ream--chokecherry	<u>Colladonus geminatus</u>	4	20	76	36	681
	<u>Typhlocyba rosae</u>	0	20	71	127	208

Walsh. The peaks occurred in June and July, respectively.

P. irroratus (Say) underwent two generations with the highest peak in June (fig. 11).

The most prevalent species in Moon's and Eckman's peach orchards were C. geminatus (Van D.), Dikraneura carneola (Stal), and P. irroratus (Say). Colladonus geminatus (Van D.) and P. irroratus (Say) passed through the season with two generations with peaks in June and September. Dikraneura carneola (Stal) possibly produced three generations with peaks in May, July, and September. The data for this species are lacking to make any definite assumptions about its life history.

Colladonus geminatus (Van D.) was the dominant species in Barlow's, Baer's and Bankhead's peach orchards. Trapping records indicated two generations in all three orchards with peaks in June and September.

Ream's chokecherry had two dominant species, namely: Colladonus geminatus (Van D.) and T. rosae (L.).

Colladonus geminatus (Van D.) was the predominant species present in all but one stone fruit orchard. This leafhopper underwent two generations in all orchards with the highest peak in September (fig. 12). Paraphlepsius irroratus (Say) was the second dominant species present in 11 orchards. This species underwent two generations with the highest peak in September in the Campbell cherry orchard and in W. White's plum orchard. The highest peak was reached in August in R. White's apricot orchard and in June in Moon's cherry orchard (fig. 13).



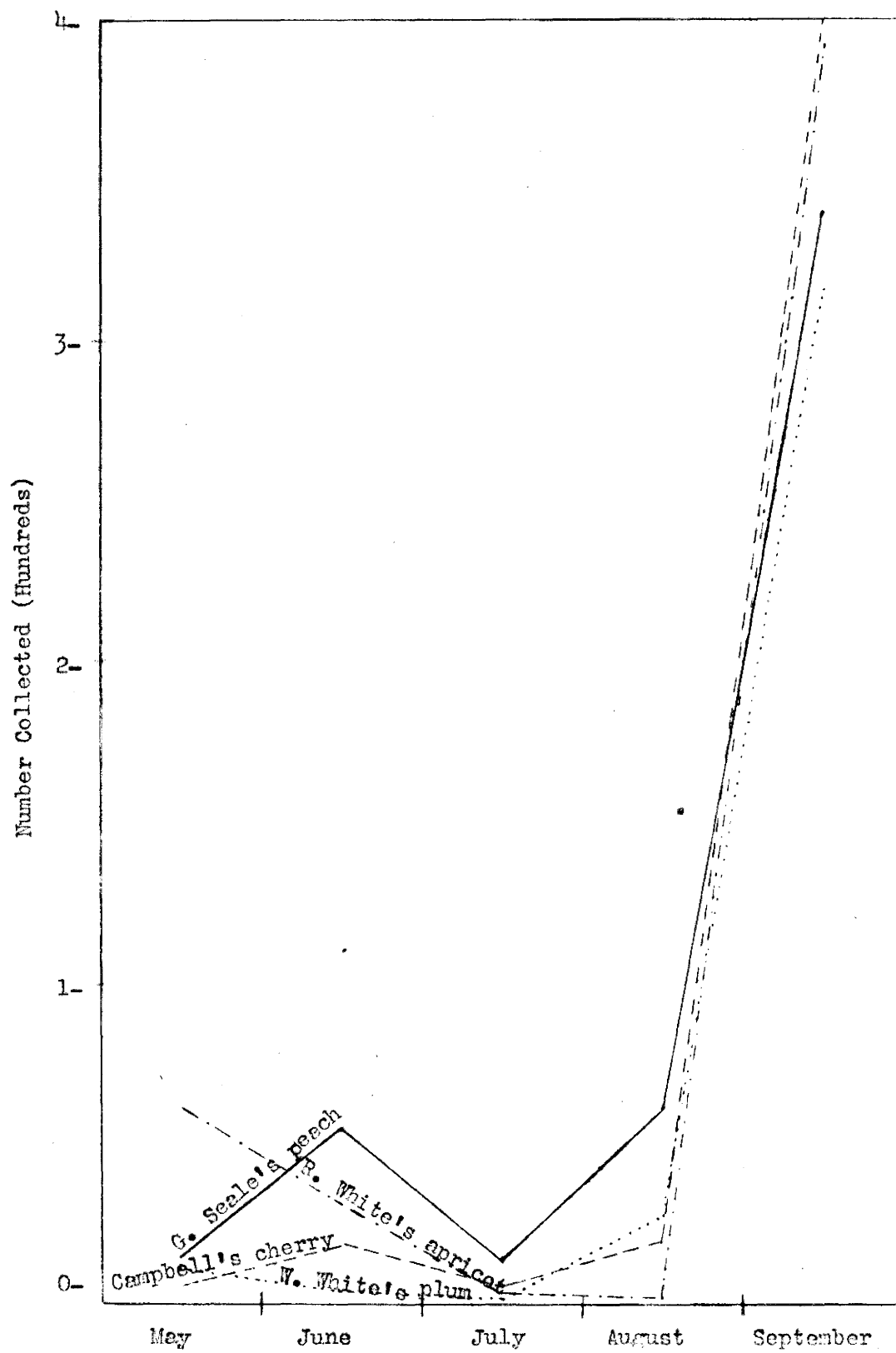


Figure 12. Seasonal abundance of Colladonus geminatus (Van D.) in four stone fruit orchards of northern Utah, 1949.

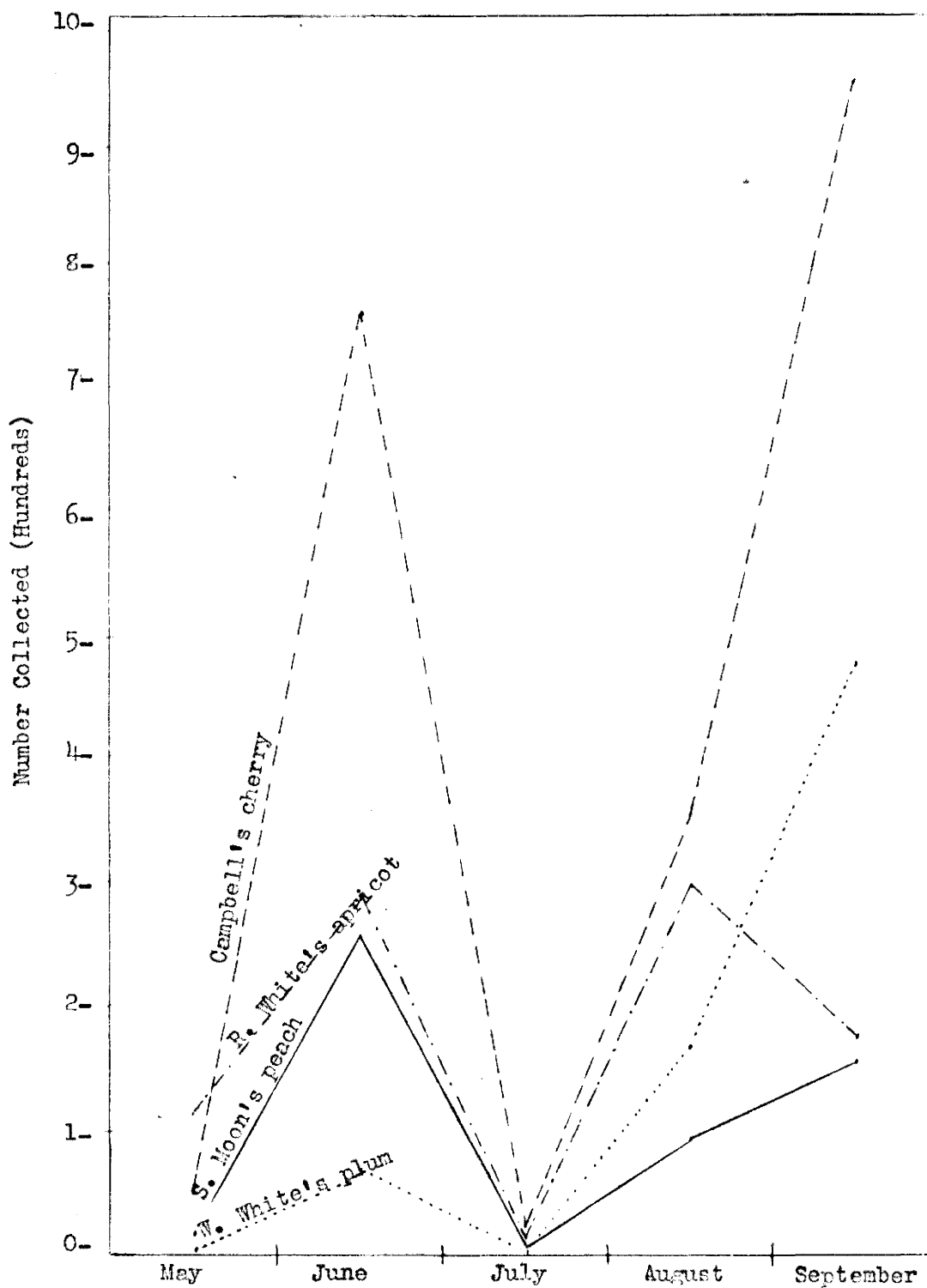


Figure 13. Seasonal abundance of Paraphlepsius irroratus (Say) in four stone fruit orchards of northern Utah, 1949.

The total number of trees, number infected, percent infected, approximate age of the trees, and total number of leafhoppers in 15 stone fruit orchards in northern Utah are shown in table 4.

#### Correlation of Leafhoppers and Percentage of Diseased Trees in Each Orchard

A survey for Western X disease was undertaken in 1949 to determine the percentage of diseased trees in each stone fruit orchard listed. An attempt was made to decide if any correlation existed between the number of leafhoppers present and the percentage of infected trees in the orchards. Table 4 suggests no such correlation; however, if further studies had been made and additional data supplied, a correlation might have existed. Two exemplary extremes were illustrated as follows: In Seale's peach orchard a high population of 1,452 leafhoppers was collected. Only 0.5 percent of the trees were diseased. W. White's peach orchard had 36.0 percent of the trees infected and only a relatively small population of 634 leafhoppers was collected.

#### Correlation of Age of Trees and Percentage of Diseased Trees in Each Orchard

A close correlation, however, existed between the age of the orchards and percentage of diseased trees. All orchards from 30 to 60 years old exhibited 4.0 to 85.0 percent of the trees infected with Western X virus disease. Young orchards from 5 to 10 years old showed 0.0 to 0.5 percent of the trees to be diseased. An explanation for this correlation is that an old orchard had been exposed longer to the virus disease than a young orchard. Consequently, it has a greater chance of becoming infected.

Table 4. Total number of trees, number infected, percent infected, approximate age, and total number of leafhoppers in 15 stone fruit orchards in northern Utah, 1949.

Property	Number		Percent Infected	Approx. Age	Number of Leafhoppers
	Trees	Infected			
G. Sesle--peach	1292	6	0.5	10 Years	1452
E. Smith--peach	500	19	4.0	40 "	241
A. Baer--peach	297	1	0.3	8 "	1923
G. Bankhead--peach	89	12	13.5	40 "	2764
W. White--peach	250	90	36.0	30 "	634
W. Smith--peach	83	21	25.3	30 "	1385
S. Moon--peach	126	44	35.0	30 "	1892
L. Barlow--peach	109	0	0.0	5 "	375
L. Eckman--peach	200	0	0.0	5 "	368
J. Stringham--peach	270	0	0.0	5 "	405
J. Campbell--cherry	72	61	85.0	40 "	6301
S. Moon--cherry	52	12	23.0	60 "	7808
R. White--apricot	180	*	-	15 "	1570
W. White--plum	89	*	-	30 "	1330
J. Ream--chokecherry	25	**	-	30 "	2285
TOTAL	3134	266	.093	-	30,733

\* These stone fruits do not show visible symptoms of the Western X virus disease.

\*\* The symptoms of the Western X virus disease were not apparent during the survey.

### Correlation of Cultural Practices and Leafhopper Abundance

Cultural practices such as cultivation and timely spray applications were essential in limiting leafhopper outbreaks in the stone fruit orchards. To illustrate this, Seale's peach orchard had 1,452 leafhoppers present on sticky traps during the season. This orchard had no spray materials applied and a heavy grass cover crop existed in the orchard during the season. Conversely, E. Smith's peach orchard had only 241 leafhoppers present. The orchard was well cultivated and sprayed during the season (fig. 8). In the Bankhead peach orchard 2,764 leafhoppers were collected. This orchard was never sprayed and a heavy cover crop was present throughout the season. Low populations of leafhoppers were encountered in the Barlow, Eckman, and Stringham peach orchards, as shown in table 4. All of these orchards were sprayed and well cultivated during the growing season.

It must be emphasized that certain plant environs adjacent to these orchards produced heavy populations of leafhoppers that migrated to and fed upon the trees. In the Campbell cherry orchard, large populations of the rose leafhopper, Typhlocyba rosae (L.), were encountered. During the season it was observed that this species had developed on the adjacent wild rose bushes and then migrated to the cherry orchard.

### Host Plant Preference of Leafhoppers

The host plant preference of leafhoppers as indicated by sticky-trap studies is illustrated in Figure 14. Inasmuch as ten peach and two cherry orchards were involved and only one orchard each of apricot, plum, and chokecherry, an average of the total number of leafhoppers collected in the peaches and cherries was computed.

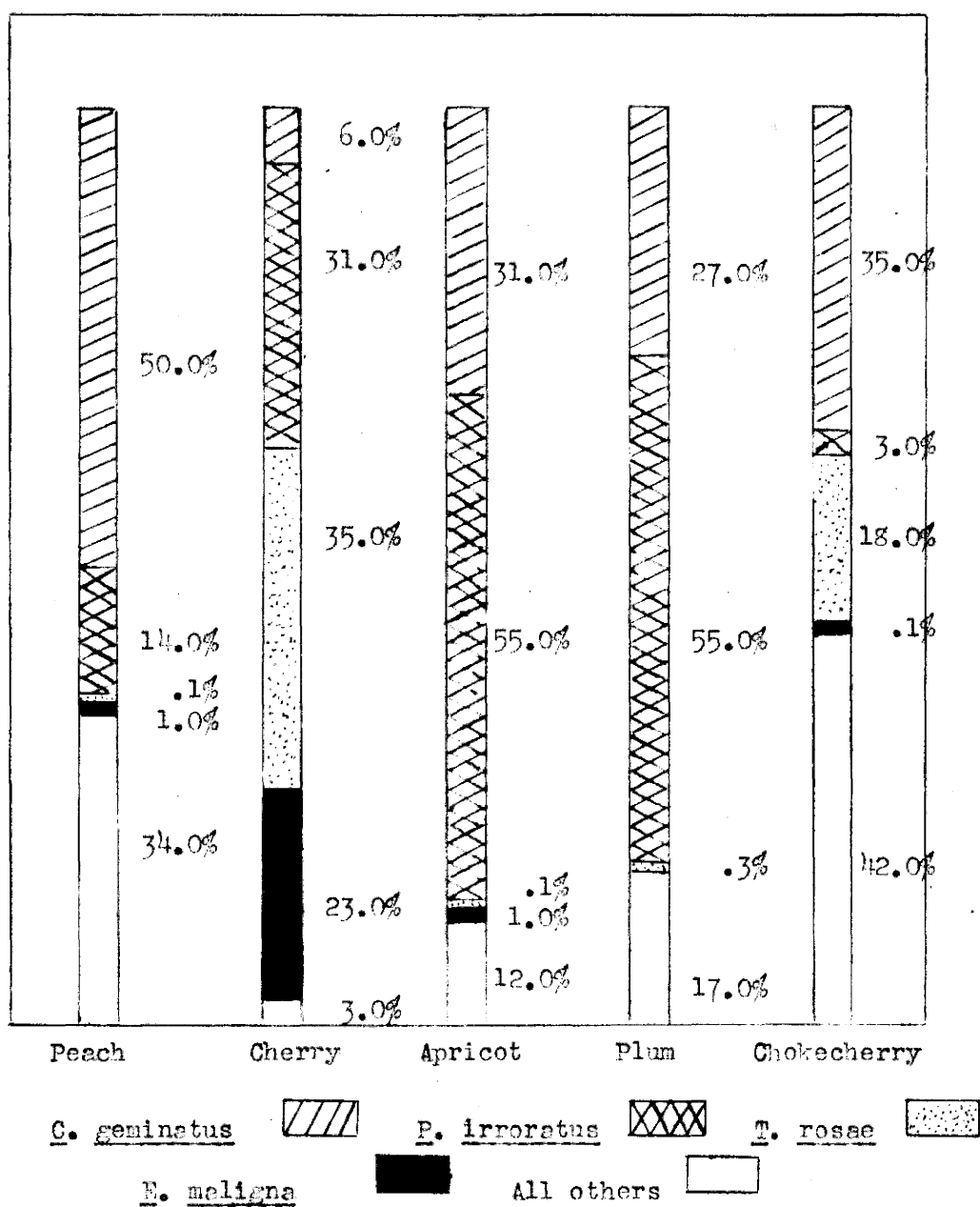


Figure 14. Host plant preference of leafhoppers as indicated by sticky-trap studies in 15 stone fruit orchards in northern Utah, 1949.

C. geminatus (Van D.) desired all the stone fruits with special preference toward peach. On peach, 50 percent of the leafhoppers collected were C. geminatus (Van D.); on cherry, 6 percent; on apricot, 31 percent; on plum, 27 percent; and on chokecherry, 35 percent.

P. irroratus (Say) preferred apricot and plum above the other three stone fruits. On apricot and plum 55 percent of the leafhoppers collected was this species, while 14, 31, and 3 percent of the sum was collected on peach, cherry, and chokecherry, respectively.

T. rosae (L.) definitely preferred cherry above all the other stone fruits studied. A second choice was chokecherry. Practically no preference was shown toward peach, apricot, and plum.

E. maligna Walsh showed a special likeness for cherry, since 23 percent of the number collected was of that species. A small preference for peach, apricot, and chokecherry occurred. No member of this species was collected on plum.

All other species of leafhoppers showed considerable preference for peach and chokecherry with a slight preference toward cherry, apricot, and plum.

## CONCLUSIONS

Studies of leafhoppers associated with stone fruit orchards showed that these species did occur and inhabit the orchards in large numbers. However, many leafhoppers may have been migrating species and may not be directly associated with the orchards. Considerably more research would have to be undertaken to confirm this.

The high incidence of C. geminatus (Van D.) and P. irroratus (Say) may be important as vectors of Western X virus diseases since they occurred very abundantly in all the stone fruit orchards studied.

Studies suggested that leafhoppers underwent one, two, and three generations during the season. Important species that had one generation were C. belli (Uhl.), T. rosae (L.), and E. maligna Walsh. The peak of all these species occurred in July. C. geminatus (Van D.) and P. irroratus (Say) underwent two generations during the season with the highest peak in June and September, respectively. D. carneola (Stal) had three generations with the highest peak in September. These life history studies may have some bearing upon the relationship of Western X virus infection in the stone fruit orchards. But again, this investigation warrants further study.

The correlation of leafhopper abundance and percentage of diseased trees in the orchards studied was not determined. Further information is needed for this study.

The correlation of the age and percentage of diseased trees in the orchards had a rather obvious explanation. The older the orchard



becomes, the greater the degree of virus spread in the orchard. Also, the longer the tree is exposed the greater chance it has of becoming infected.

Clean cultivation and spray programs in stone fruit orchards will definitely limit the population of leafhoppers. However, since cover crops are essential for peach tree growth, spraying of these cover crops is vital.

Host preference studies showed that C. geminatus (Van D.) preferred peach above all other stone fruits studied. P. irroratus (Say) had a special preference for plum and apricot trees, while T. rosae (L.) and E. maligna Walsh definitely preferred cherry over other stone fruits.

## SUMMARY

1. Since leafhoppers are considered to be high suspects as vectors of stone fruit viruses, studies were undertaken in 15 stone fruit orchards of northern Utah in 1949 to determine their occurrence, monthly abundance, and host preference.
2. One hundred fifty sticky-trap boards were distributed in ten peach, two cherry, one apricot, one plum, and one chokecherry orchard from May to September 1949 in five counties of northern Utah. Sweep nets were used in collecting the leafhoppers from the plant environs adjacent to the orchards.
3. A total of 750 traps were exposed during the growing season. The leafhopper specimens were collected, cleaned, and sent to Washington, D. C. for positive identification.
4. Eighty-eight species of leafhoppers were collected from the 15 stone fruit orchards studied.
5. The most abundant species collected in each orchard was C. geminatus (Van D.).
6. A total of 881 leafhoppers was collected on sticky-trap boards in May; 6,665 in June; 6,083 in July, 4,852 in August; and 12,252 in September. A total of 30,733 leafhoppers was collected during the season.
7. In general, studies suggested that two generations of leafhoppers occurred with peaks in June and September. The highest peak occurred in September.
8. C. geminatus (Van D.) and P. irroratus (Say) underwent two generations with peaks in June and September.

9. T. rosae (L.) and E. maligna Walsh underwent one generation during the season with a peak in July.
10. No correlation existed between the number of leafhoppers and percentage of infection in the stone fruit orchards.
11. A close correlation existed between the age of orchards and percentage of diseased trees.
12. Effective cultural practices are essential in controlling leafhopper outbreaks in the orchards.
13. Host plant preference studies showed that C. geminatus (Van D.) preferred peach above all other stone fruits studied.
14. P. irroratus (Say) preferred apricot and plum trees.
15. T. rosae (L.) and E. maligna Walsh definitely chose cherry as their preferred host.
16. All other species of leafhoppers showed considerable preference for peach and chokecherry and a slight preference for the other three stone fruits.
17. One hundred seventy-three species of leafhoppers were collected in the stone fruit orchards and adjacent plant environs in northern Utah from 1937 to 1949, inclusive. These are listed in the appendix.

## APPENDIX

A List of Leafhoppers Collected in Stone Fruit Orchards and Adjacent  
Plant Environs in Northern Utah, 1937-1949.

The following leafhoppers were collected by the use of sticky-trap boards and sweep nets. These collections listed from 1937-1944 were made by L. D. Christenson and D. D. Jensen; from 1945-1947, by L. S. Jones and E. W. Anthon; from 1948-1949, by G. H. Kaloostian and M. W. Nielson, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.

Aceratagallia abrupta Oman: Bountiful, 8-8-45, cover.

A. arida Oman: Brigham City, 7-23-37, soil; Willard, 7-26-37, cover; Brigham City, 4-20-38, cover; Willard 4-21-38, cover; Brigham, 8-26-38, cover; Provo, 10-28-38, cover; Bountiful, 9-24-40, morning glory; Willard, 9-26-40, alfalfa; Brigham, 9-27-40, cover; Centerville, 9-23-40, peach, apricot; Provo, 9-13-41, mint; Provo, 9-13-41, alfalfa; Provo, 9-13-41, cover; Bountiful, 9-15-41, alfalfa; Brigham, 9-19-41, peach, cover; Bountiful, 9-8-42, cover; 6-28-43, cover; Farmington, 7-17-49, clover.

A. curvata Oman: Bountiful, 6-28-43, cover; 6-19-45, rabbit bush; 7-16-45, chokecherry, cover; 8-13-45, wild rose, grape, ragweed; Holladay, 9-13-45, peach.

A. fuscscripta Oman: Centerville, 6-12-46, ragweed, grasses.

A. poudris Oman: Bountiful, 9-11-42, cover.

A. sanguinolenta (Prov.): Brigham, 8-25-38, cover; Willard, 4-21-38, cover; Brigham, 9-11-39, cover; Provo, 8-31-40, cover; Willard,

- 9-26-40, Malva rotundifolia, alfalfa; Brigham, 9-27-40, cover;  
 Centerville, 9-23-40, peach; Bountiful, 9-14-41, alfalfa;  
 Bountiful, 6-28-43, cover; Holladay, 9-13-45, peach.
- A. uhleri (Van D.): Bountiful, 7-28-45, morning glory, ragweed.
- A. vulgaris Oman: Willard, 7-26-37, cover; Provo, 9-13-41, cover;  
 Brigham, 9-19-41, cover; Bountiful, 9-8-42, cover.
- Aceratagallia sp.: Brigham, 9-8-39, cover; Willard, 9-9-39, cover;  
 Provo, 8-31-40, alfalfa; Willard, 9-27-40, Solanum nigrum; Willard,  
 9-18-41, cover; Farmington, 6-24-49, grass, grain, weeds.
- Acusana sp.: Providence, August 1949, trapped on peach.
- Agallia quadripunctata (Prov.): Provo, 6-1-40, cover.
- Agallia sp.: Provo, 10-28-39, soil.
- Agalliopsis novellina Oman: Provo, 6-1-40, cover; Providence, June 1949,  
 trapped on peach.
- Agalliopsis sp.: Providence, August 1949, trapped on chokecherry.
- Aligia falcata Hepner: Bountiful, 6-7-45 to 9-21-45, trapped on peach.
- A. munda (Ball): Bountiful, 7-27-45, to 9-21-45, trapped on peach.
- Aligia sp.: Bountiful, 9-16-41, peach; Bountiful, 9-24-41, chokecherry;  
 Bountiful, July 1949, trapped on peach.
- Aphrodes albifrons (L.): Bountiful, August 1949, trapped on peach.
- Balclutha impicta (Van D.): Farmington, 5-19-48, cover; Providence,  
 July 1949, trapped on peach.
- Balclutha sp.: Willard, 9-9-39, cover; Farmington, 7-19-49, clover;  
 Springville, July 1949, trapped on peach.
- Ballana bicornis DeL.: Bountiful, 7-28-45, cover; Providence, July 1949,  
 trapped on chokecherry.

Ballana sp.: Bountiful, 7-27-45 to 9-21-45, trapped on peach; Bountiful, July 1949, trapped on peach.

Caladonus coquilletti (Van D.): Provo, July 1949, trapped on peach.

Chlorotettix stolatus Ball: Providence, September 1949, trapped on peach.

Chlorotettix sp.: Providence, September 1949, trapped on chokecherry,

Cicadella melissae (Curt.): Provo, 6-1-40, cover; Bountiful, 9-15-41, cover.

Cicadella sp.: Providence, July 1949, trapped on peach.

Circulifer tenellus (Baker): Centerville, 9-23-40, peach; Bountiful, 9-29-40, chokecherry; 9-15-41, ragweed; Bountiful, 9-11-42, cover; 6-19-43, cover; Farmington, 7-23-49, clover; Farmington, June 1949, trapped on sweet cherry.

Colladonus belli (Uhler): Bountiful, 6-19-43, cover; Bountiful, 5-16-45, chokecherry, cover; 6-9-45, sour cherry; 5-6-45, sweet cherry; Springville, July 1949, trapped on peach; Farmington, 7-17-49, clover.

C. citrinifrons (G. & B.): Providence, September 1949, trapped on chokecherry.

C. flavocapitatus (Van D.): Providence, September 1949, trapped on peach, chokecherry; Willard, September 1949, trapped on plum; N. Ogden, September 1949, trapped on sweet cherry.

C. geminatus (Van D.) <sup>1/</sup>: Centerville, 9-23-40, peach, wild plum, apricot, sweet cherry; Bountiful, 9-23-40, chokecherry; Provo, 9-13-41, peach; Willard, 9-18-41, peach, cover; Bountiful, 9-21-41,

<sup>1/</sup> These species were collected throughout Utah.

ragweed, alfalfa; Bountiful, 9-11-42, peach, chokecherry, cover; Centerville, 5-21-46, poplar; Bountiful, 6-10-46, sweet cherry, willow; Farmington, 6-1-49, willow, cover, grasses; Provo, May-September 1949, trapped on peach; Willard, May-September 1949, trapped on plum, peach; Farmington, May-September 1949, trapped on sweet cherry, peach, apricot.

C. montanus (Van D.) 1/: Willard, 9-26-40, peach; Provo, 9-13-41, peach, 9-14-41, sweet cherry, 9-15-41, mint, alfalfa; Bountiful, 6-19-43, cover, 6-21-45, peach, poplar; Centerville, 5-27-46, ragweed, grasses; Bountiful, 6-7-46, willow; 6-14-46, currant; Farmington, 6-18-46, rose; Holladay, 8-5-46, chokecherry; Providence, May-September 1949, trapped on chokecherry, peach; Willard, May-September 1949, trapped on plum, peach; Farmington, May-September 1949, trapped on peach, sweet cherry, apricot.

Colladonus sp.: Providence, September 1949, trapped on chokecherry; Willard, September 1949, trapped on peach.

Cherne sp.: Wellsville, 7-18-49, grain.

Deltocephalus dorsti Oman: Bountiful, 6-21-45, cover.

D. grex Oman: 1/: Willard, 9-18-41, aflafila; Centerville, 9-23-41, peach; Provo, 9-13-41, cover; Bountiful, 7-27-45 to 9-21-45, trapped on peach; Willard, May-September 1949, trapped on peach.

D. sonorus Ball: Bountiful, 8-8-45, morning glory, grasses.

Dikraneura absenta DeL. & Cald.: Centerville, 9-16-41, peach; Willard, 9-13-41, peach, cover; Bountiful, 5-16-45, cover, 6-21-45, willow.

1/ These species were collected throughout Utah.

D. carneola (Stal): Centerville, 9-23-40, peach, apricot; Bountiful, 9-23-40, chokecherry; Willard, 9-26-40, peach; Brigham, 9-27-40, sweet cherry, chokecherry; Provo, 9-13-41, sour cherry; Willard, 9-20-41, peach, cover; Bountiful, 5-7-45 to 7-27-45, trapped on peach; Bountiful, 6-3-46, cover; 6-7-46, sweet cherry; 6-12-46, plum; Farmington, 6-17-46, cover; Providence, 6-22-49, cover; Providence, May-September 1949, trapped on peach, chokecherry; Willard, May-September 1949, trapped on peach, plum; Farmington, May-September 1949, trapped on peach, sweet cherry, apricot.

Dikraneura sp.: Willard, 4-21-38, cover; Willard, 9-21-40, cover; N. Ogden, May-September, 1949, trapped on sweet cherry; Farmington, May-September 1949, trapped on sweet cherry.

Dikrella cruentata Gill.: Centerville, 9-23-40, peach, apricot, sweet cherry; Provo, 9-13-41, peach; Centerville, 9-16-41, peach, apricot, wild plum; Providence, July-September 1949, trapped on peach, chokecherry; Farmington, July-September 1949, trapped on apricot.

Draeculacephala sp.: Farmington, 7-26-40, willow.

Empoasca abrupta DeL.: Farmington, June 1949, trapped on sweet cherry.

E. alboneura Gill.: Willard, 7-26-37, cover; Bountiful, 9-24-40, ragweed, cover; Willard, 9-26-40, aflafla; Bountiful, 9-15-41, ragweed; Brigham, 9-19-41, cover; Centerville, 9-16-41, cover; Centerville, 5-27-46, ragweed, grass; Willard, July-September 1949, trapped on peach, plum; Farmington, July-September 1949, trapped on peach, apricot.

E. atrolabes Gill.: Bountiful, 8-13-45, grape, wild rose; Holladay, 9-13-45, peach, chokecherry.



- E. bipunctata (Osb.): Provo, 8-31-40, peach; Bountiful, 9-24-40, peach; 9-15-41, plum.
- E. calyxa Oman and Wheeler: Bountiful, 9-11-42, apricot.
- E. cerea DeL.: Bountiful, 9-12-42, chokecherry, 6-21-45, willow, 8-6-45, cover.
- E. clypeata G. & B.: Bountiful, 6-15-45, willow, 6-25-45, cottonwood.
- E. decora DeL. & D.: Bountiful, 9-16-41, chokecherry.
- E. deluda DeL.: Providence, June 1949, peach.
- E. digita DeL.: Bountiful, 7-28-45, willow.
- E. filamenta DeL.: Provo, 9-13-41, mint; Bountiful, 9-15-41, ragweed, cover; Centerville, 9-16-41, cover; Centerville, 9-16-41, peach; Bountiful, 6-7-45 to 9-21-45, trapped on peach; Bountiful, 8-8-44, sweet cherry; 6-6-46, plum; Providence, May-September 1949, trapped on peach, chokecherry; Willard, May-September 1949, trapped on peach, plum; Farmington, May-September 1949, trapped on sweet cherry, peach, apricot.
- E. incida DeL.: Bountiful, 6-25-45, willow.
- E. maligna Walsh: Bountiful, 6-7-45 to 9-21-45, trapped on peach; Bountiful, 6-7-46, sweet cherry, plum; Providence, June-September 1949, trapped on peach, chokecherry; Willard, June-September 1949, trapped on peach, plum; Farmington, May-September 1949, trapped on peach, sweet cherry, apricot.
- E. aspersa Oman and Wheeler: Provo, 8-21-40, Artemisia; Bountiful, 6-19-45, rabbit bush.
- E. nigra G. & B.: Bountiful, 9-8-42, cover; 6-13-45, blue sage.
- E. nigra var. typhlocyboides G. & B.: Provo, 6-12-40, cover; Bountiful, 9-16-41, chokecherry.

E. panda Del.: Farmington, June 1949, trapped on sweet cherry.

E. patula Del.: Bountiful, 6-6-46, willow; Farmington, 6-17-46, sweet cherry.

E. pectinata Del.: Farmington, 6-18-46, rose, willow; Providence, July 1949, trapped on peach.

E. pergandei Gill.: Centerville, 9-16-41, black locust, cover; Bountiful, 8-13-45, honey locust; Providence, July 1949, trapped on peach.

Empoasca spp.: Willard, 4-21-38, cover; Brigham, 8-24-39, cover; Provo, 8-31-40, peach; Bountiful, 9-24-40, peach, ragweed; Bountiful, 9-15-41, ragweed; Willard, 9-18-41, cover; Brigham, 9-19-41, peach, cover; Centerville, 9-23-40, peach, sweet cherry; Brigham, 9-27-40, chokecherry; Centerville, 9-16-41, wild plum, cover; Bountiful, 5-7-45 to 9-21-45, trapped on peach; Providence, May-September 1949, trapped on peach, chokecherry; Willard, May-September 1949, trapped on peach, plum; Farmington, May-September 1949, trapped on peach, sweet cherry, apricot; Farmington, 6-14-49, willow.

Empoasca sp. aspera group: Bountiful, May 1949, trapped on peach.

Empoasca sp. fabae group: Farmington, June 1949, trapped on sweet cherry.

Empoasca sp. (Kybos) spp.: Providence, May-June 1949, trapped on chokecherry; Farmington, May-June 1949, trapped on peach, sweet cherry, apricot.

Endria inimica (Say): Willard, 9-18-41, cover; Brigham 9-19-41, cover.

E. montana Del. & S.: Brigham, 8-26-38, cover.

Errastunus sobrinus (D. & Sloes.): Providence, 6-1-49, cover.

Erythroneura coloradensis (Gill.): Brigham, 9-27-40, sweet cherry.

E. cornipes Bean.: Bountiful, 9-24-40, chokecherry.

E. furcillata Bean.: Bountiful, 9-24-40, chokecherry; 9-17-41, chokecherry; Ogden, 9-8-49, sweet cherry.

E. vitis (Harris): Bountiful, 8-13-45, grape, wild rose.

E. zizac Walsh: Brigham, 9-11-39, grape; Centerville, 9-16-41, wild plum  
Providence, May-September 1949, trapped on peach, chokecherry;  
Willard, May-September 1949, trapped on peach, plum, Farmington,  
May-September 1949, trapped on peach, sweet cherry, apricot.

Erythroneura spp.: Bountiful, 5-7-45 to 7-27-45, trapped on peach;

Providence, May-September 1949, trapped on peach, plum; Farmington,  
May-September 1949, trapped on peach, sweet cherry, apricot.

Erythroneura spp.: obliqua group: Centerville, 9-23-40, peach; Centerville, 9-16-41, wild plum; Farmington, July 1949, trapped on sweet cherry.

Erythroneura sp.: vulnerata group: Centerville, July 1949, trapped on peach.

Euscolidius maculipennis DeL. & D.: Bountiful, 6-19-43, cover; 7-2-45, cover; 9-13-45, grape, wild rose.

E. schenkii (Kbm.): Bountiful, 6-7-45 to 9-21-45, trapped on peach;  
Bountiful, 6-3-45, grass; 8-5-46, willow; Centerville, 6-6-46, cover;  
Farmington, 6-24-48, cover; Farmington, 7-15-49, clover, grain, willow;  
Providence, 7-8-49, willow; Providence, June-September 1949, trapped on peach;  
Farmington, June-September 1949, trapped on peach, apricot.

Eutettix aequalis Hepner: Farmington, 6-26-46, oak; Provo, May 1949,

trapped on peach; Farmington, 7-22-49, oak.

Eutettix sp.: Centerville, 9-23-40, peach; Bountiful, 9-24-40, cover,

chokecherry; Bountiful, 6-7-45 to 9-21-45, trapped on peach;

Providence, July-September 1949, trapped on chokecherry; Farmington,

July-September 1949, trapped on peach.

Exitianus exitiosus (Uhler): Farmington, 7-21-48, cover.

E. obscurinervis (Stal): Bountiful, 9-11-42, cover; 7-19-43, cover;

7-28-45, morning glory, ragweed; 8-13-45, grape, wild rose;

Bountiful, 7-27-45 to 9-21-45, trapped on peach; Willard, 9-16-41,

alfalfa.

Fieberella florii (Stal): Centerville, 9-23-40, peach, sweet cherry,

9-16-41, wild plum; Bountiful, 9-11-42, peach, 7-7-45, plum;

7-26-45, cover, cottonwood; 8-6-45, grape; 8-8-45, peach;

Holladay, 9-7-45, chokecherry; Bountiful, 6-7-45 to 9-21-45,

trapped on peach; Bountiful, 6-10-46, willow; Farmington, 7-22-48,

willow; Farmington, 7-30-49, oak, alfalfa; Providence, July-

September 1949, trapped on peach; Willard, July-September 1949,

trapped on peach, plum; Farmington, July-September 1949, trapped

on peach, apricot.

Gypona aculeata Del.: Bountiful, 7-20-45, alfalfa.

G. bimaculata Spang.: Bountiful, 7-20-45, alfalfa; 7-26-45, plum, willow

cover.

G. melonata Spang.: Bountiful, 9-11-42, cover; Willard, 9-24-49, cover,

G. serrata (Del.): Bountiful, 7-21-45, Parshia tridentata.

G. unicolor Stal: Willard, 9-18-41, cover; Brigham, 9-19-41, cover.

G. verticalis Stal: Provo, 8-31-40, alfalfa; Bountiful, 6-7-45 to 9-21-45, trapped on peach; Bountiful, 7-31-46, willow; Holladay, 8-5-46, peach; Farmington, 7-23-48, oak; Providence, July-September 1949, trapped on chokecherry; Farmington, July-September 1949, trapped on peach, sweet cherry.

Gypona sp.: Provo, 8-23-38, peach; Brigham, 9-11-39, plum, cover; Farmington, 7-27-48, willow; Farmington, September 1949, trapped on sweet cherry.

Gyponana flavilineata (Fitch): Holladay, 9-7-45, peach.

G. hasta Del.: Bountiful, 6-7-45 to 7-27-45, trapped on peach; Bountiful, May 1949, trapped on peach.

G. procera Del.: Farmington, 7-27-48, willow; Farmington, 8-16-48, oak.

G. querci Del.: Farmington, 7-12-48, oak.

Gyponana sp.: Farmington, 6-24-48, willow; Farmington, 7-17-49, willow; N. Ogden, July-September 1949, trapped on sweet cherry; Farmington, July-September 1949, trapped on peach.

Helochara delta Oman: Bountiful, 8-3-45, morning glory, grass.

H. communis Fitch: Willard, 4-21-38, cover; Brigham, 4-24-38, cover; Provo, 8-23-38, cover; Providence, 4-11-49, grass.

Helochara sp.: Centerville, 8-16-48, cover; Farmington, 7-25-49, clover; Bountiful, July 1949, trapped on peach.

Idiocerus alternatus Fitch: Bountiful, 9-16-42, cover; 7-18-43, cover; 5-12-45, willow; 8-13-45, grape, wild rose; Providence, 5-10-49, willow; Providence, September 1949, trapped on chokecherry.

- I. amoemus Van D.: Bountiful, 6-3-46, willow; 6-10-46, sweet cherry; Farmington, 6-26-46, oak; Bountiful, September 1949, trapped on peach.
- I. duzeei Prov.: Providence, July 1949, trapped on peach.
- I. femoratus Ball: Bountiful, 5-12-45, willow.
- I. morosus Ball: Willard, 4-21-38, cover; Providence, July 1949, trapped on peach.
- I. nervatus Van D.: Bountiful, 6-21-46, cottonwood.
- I. pallidus Fitch: Bountiful, 6-25-45, cottonwood.
- I. productus G. & B.: Bountiful, 7-28-45, willow.
- I. provencheri Van D.: Providence, July 1949, trapped on chokecherry, peach.
- I. suturalis Fitch: Bountiful, 7-24-45, cover.
- I. scurra Germ.: Bountiful, 6-26-45, poplar; Centerville, 6-3-46, poplar.
- I. snowi G. & B.: Bountiful, 6-19-43, cover; 7-6-45, willow; 7-16-45, chokecherry; 7-28-45, morning glory, ragweed; Bountiful, 6-7-45 to 9-21-45; trapped on peach; Centerville, 5-21-46, poplar; Bountiful 6-7-46, willow; Farmington, 6-17-48, willow; Farmington, 7-17-49, willow; Providence, July 1949, trapped on peach.
- Idiocerus spp.: Bountiful, 9-16-41, chokecherry; Willard, 9-21-40, chokecherry, peach; Bountiful, 5-7-45 to 7-27-45, trapped on peach; Farmington, 7-17-49, clover; Providence, July 1949, trapped on peach, chokecherry.

Keonolla confluens (Uhler): Bountiful, 6-10-46, sweet cherry, cover,

8-1-46, willow; Centerville, 9-21-46, poplar; Centerville, 8-13-48,

cover; Farmington, 7-22-48, willow; Farmington, 7-17-49, willow.

K. dolobrata (Ball): Holladay, 9-13-46, peach.

Laevicephalus sp.: Provo, 6-1-40, cover; 8-31-40, mint; Bountiful,

9-15-41, alfalfa; Bountiful, 9-8-42, cover; Providence, 6-11-49,

grass.

Limotettix parallelus (Van D.): Bountiful, 6-7-45 to 7-27-45, trapped a  
on peach.

Macropsis hesperia Breakey: Bountiful, 6-26-45, poplar.

M. viridis (Fitch): Bountiful, 6-25-45, willow, cottonwood.

Macropsis spp.: Bountiful, 7-24-43, cover; Bountiful, 5-7-45 to 7-27-45,

trapped on peach; Centerville, 5-21-46, poplar; Bountiful, 6-7-46,

willow; Providence, 6-24-49, willow; Providence, July 1949, trapped

on peach; Provo, 6-18-49, willow.

Macrosteles divinus (Uhler): Provo, 9-13-41, cover; Willard, 9-18-41,

cover; Bountiful, 9-8-42, cover; 6-19-43, cover; 6-21-45, cover;

Holladay, 9-13-45, peach, chokecherry; Bountiful, 6-7-45 to 9-21-45,

trapped on peach; Bountiful, 6-14-46, currant; Centerville, 6-16-46,

ragweed, grass; Farmington, 9-13-48, celery; Providence, 6-21-49,

Erodium, clover; Providence, May-September 1949, trapped on peach,

chokecherry; Farmington, May-September 1949, trapped on peach, apricot.

Macrosteles sp.: Brigham, 9-11-39, cover.

Mesamia colaredensis (G. & B.): Bountiful, 9-24-40, chokecherry;

Bountiful, 9-11-42, peach.

M. straminea (Osb.): Bountiful, 6-19-43, cover.

Mesania Sp.: Bountiful, 6-10-49, weeds.

Neocoelidia obscura Baker: Providence, August 1949, trapped on chokecherry.

Neokolla hieroglyphica (Say): Bountiful, 5-9-45, willow; 6-25-45, cotton-wood; Holladay, 9-7-45, peach.

N. hieroglyphica var. uhleri (Ball): Bountiful, 7-27-45 to 9-21-45, trapped on peach.

Nesostoles neglectus (DeL. & D.): Providence, 6-9-49, grass.

Nesostoles sp.: Bountiful, 5-7-45 to 7-27-45, trapped on peach.

Norvellina chenopodii (Osb.): Willard, 9-27-40, peach; Provo, 9-13-41,

peach; Bountiful, 9-15-41, cover; Bountiful, 7-27-45 to 9-21-45,

trapped on peach; Bountiful, July-September 1949, trapped on peach.

N. scitula (Ball): Provo, 8-31-40, Artemisia; Bountiful, 9-15-41,

cherry; Bountiful, 8-13-45, morning glory, grass; Farmington, August 1949, trapped on sweet cherry.

Norvellina sp.: Farmington, 9-13-49, alfalfa; Farmington, July 1949,

trapped on peach.

Oncopsis coloradensis (Baker): Providence, 6-16-49, willow.

O. verticis (Say): Bountiful, June-September 1949, trapped on peach.

Opius stactogelus Fleber: Provo, 8-31-40, peach; Bountiful, 6-7-45

to 9-21-45, trapped on peach; Bountiful, August-September 1949,

trapped on peach.

Osbornellus borealis DeL. & M.: Bountiful, 9-14-42, chokecherry,

Bountiful, 7-27-45 to 9-21-45, trapped on peach; Providence,

July-September, 1949, trapped on peach, chokecherry; Willard,



July-September 1949, trapped on peach, plum; Farmington, July-

September 1949, trapped on peach, sweet cherry, apricot.

Osbornellus sp.: Centerville, 9-23-40, peach; Farmington, June 1949,

trapped on apricot; Farmington, 7-12-49, willow.

Parabolocratus viridis Uhler: Bountiful, 6-21-45, grass, Ogden, 4-24-49,

willow.

Parabolocratus sp.: Farmington, 7-22-49, clover.

Paraphlepsius eburneolus Osb. & L.: Bountiful, 8-13-45, morning glory,

weeds.

P. irroratus (Say): Provo, 8-23-38, peach, cover; Brigham, 8-26-38,

peach, cover; Willard, 9-26-40, cover; Provo, 9-31-40, alfalfa;

Provo, 9-14-41, cherry, apricot, mint; Holladay, 9-13-45, peach,

chokecherry; Centerville, 5-27-46, cover; 6-6-46, wheat; Bountiful,

6-7-46, wheat; Bountiful, 6-7-45 to 9-21-45, trapped on peach.

Farmington, 6-24-48, willow; Farmington, 8-18-48, oak; Providence,

May-September, 1949, trapped on peach, chokecherry; Willard, May-

September 1949, trapped on peach, plum; Farmington, May-September

1949, trapped on peach, sweet cherry, apricot.

Paraphlepsius sp.: Willard, 4-21-38, cover; Brigham, 8-25-38, cover;

Willard, 9-26-40, peach; Willard, 4-21-38, cover; Bountiful,

9-24-40, cover; Willard, 9-26-40, cover; Bountiful, August-September,

1949, trapped on peach.

Psammotettix affinis (G. & B.): Bountiful, 9-24-40, cover; Brigham,

9-19-41, cover; Centerville, 5-27-46, cover.

P. attenuans DeL. & D.: Bountiful, 9-29-40, cover; Centerville, 9-16-41, cover; Bountiful, 9-16-41, chokecherry; Centerville, 6-12-46, cover,

P. striatus (L.): Brigham, 9-11-39, cover; Providence, 9-23-49, grass.

Psammotettix sp.: Farmington, 6-18-49, grain; Willard, July 1949, trapped on peach, plum.

Onotus missellus (Ball): Bountiful, 6-15-45, cover.

Scaphoideus scleustus DeL. & M.: Bountiful, 8-13-45, cover.

S. crassus DeL. & M.: N. Ogden, July-September 1949, trapped on sweet cherry.

Scaphoideus sp.: Farmington, July-September 1949, trapped on sweet cherry, peach.

Scaphytorius acutus (Say): Centerville, 9-23-40, wild plum; Bountiful, 9-23-40, chokecherry; Provo, 9-23-40, peach, mint, alfalfa; Bountiful, 9-16-41, alfalfa; Provo, 9-13-41, cover; Bountiful, 6-21-45, willow; Holladay, 9-13-45, chokecherry; Bountiful, 7-27-45 to 9-21-45, trapped on peach; Farmington, 6-1-49, clover; Providence, July-September 1949, trapped on peach, chokecherry.

S. latus (Baker): Bountiful, 7-27-49 to 9-21-45, trapped on peach.

S. oregonensis (Baker): Mantua, 9-19-41, chokecherry.

Scaphytorius sp.: Provo, 8-31-40, cover; Providence, May-September 1949, trapped on peach, chokecherry.

Scleroracrus sp.: Providence, August 1949, trapped on peach.

Sorhoanus debilis (Uhler): Bountiful, 6-15-45, grass, weeds; Logan, 6-11-49, grass.

S. uhleri Oman: Farmington, 6-17-46, grass, weeds; Centerville, 5-27-45, ragweed, grass.

Stragania sp.: Providence, August 1949, trapped on peach; Willard, August 1949, trapped on plum.

Texanamus majestus O. & B.: Provo, 9-13-41, sunflower.

T. ovatus Van D.: Provo, 4-23-38, cover.

T. spatulatus Van D.: Willard, 9-26-40, cover; Centerville, 9-23-40, peach; Provo, 6-23-41, cover; Willard, 9-15-41, cover; Providence, May-September 1949, trapped on peach; Farmington, May-September 1949, trapped on peach, sweet cherry.

Twiningia sp.: Bountiful, 9-16-42, cover.

Typhlocyba flavomarginata G. & B.: Farmington, 6-26-46, oak; Providence, July 1949, trapped on peach.

T. frogatti Baker: Bountiful, 6-7-45 to 7-27-45, trapped on peach.

T. pomaria McA.: Brigham, 8-25-38, peach; Provo, 8-31-40, sweet cherry; Willard, 9-26-40, peach; Provo, 9-13-41, peach, sweet cherry, apricot; Centerville, 9-16-41, wild plum; Bountiful, 6-7-45 to 9-21-45, trapped on peach; Holladay, 8-5-46, chokecherry; Providence, May-September 1949, trapped on peach, chokecherry; Farmington, May-September 1949, trapped on peach, sweet cherry.

T. prunicola DeL. & Dav.: Bountiful, 6-15-45, plum; Centerville, 6-6-46, wheat; Bountiful, 6-6-46, apple, plum, sweet cherry; 6-10-46, willow; Willard, May-September 1949, trapped on plum, peach.

T. rosae (L.): Provo, 10-22-38, peach, cover; 10-28-39, peach, alfalfa, cover; Bountiful, 7-29-44, plum; 7-2-45, wild rose; 8-6-45, sweet

cherry; Holladay, 9-13-45, peach; Bountiful, 6-7-46, apple, plum; Bountiful, 5-7-45 to 9-21-45, trapped on peach; Providence, May-September 1949, trapped on peach, chokecherry; Willard, May-September 1949, trapped on peach, plum; Farmington, May-September 1949, trapped on sweet cherry, peach.

Tryplocyba spp.: Brigham, 9-11-39, cover; Bountiful, 9-23-40, chokecherry; Providence, May-September 1949, trapped on peach, chokecherry.

Xerophloea viridis (F.): Bountiful, 9-8-42, cover; 6-19-43, cover; 6-15-45, grass, weeds; 6-19-45, rabbit brush; Farmington, 7-30-49, willow; Willard, 7-31-49, willow.

X. zionis Lawson: Willard, 4-21-38, cover.

Xerophloea sp.: Provo, July 1949, trapped on peach.

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